Frontispiece

THE JOY OF HEALTH AND STRENGTH: A FOOTBALL GAME

GENERAL HYGIENE

REVISED

BY

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PREFACE

THE knowledge gained by scientific research in hygiene has been standardized and simplified, and the average person can now apply hygienic principles to daily living as accurately as he can apply the scientific principles of mechanical engineering to automobiling and radio telephoning. An ordinary person can now operate and care for the machinery of his body with intelligence and certainty.

This book supplements the author's "Personal Hygiene, Revised" and is designed for pupils in the sixth, seventh, and eighth grades. It supplies the kind of hygienic information which physicians and health officers have found that the people need. It is also a guide to teachers in supervising and advising the pupils in their health habits and actions, and in directing them to observe the sanitary arrangements and practices in the school, the home, and the community.

The scientific information contained in this book is of a grade commensurate with the mental age of the pupils for whom it is designed. While "Personal Hygiene, Revised" dwells upon the practice of health chores by the individual pupils, "General Hygiene, Revised" emphasizes civic responsibilities, and will prepare the pupils for their future duties along public health lines.

The pupils who will use this book have the mental capacity and attainments of the average voting citizen, and can readily understand the principles on which modern public

health movements are founded. About twenty-five years, or a generation of time, have hitherto been required for a knowledge of current progress in medicine and hygiene to become the common possession of the people; but proper hygienic instruction in the school would reduce the years to less than ten, or the time which a pupil usually spends in a public school. The citizen who is properly informed regarding the possibilities of attaining physical and mental health will do what he can to make that knowledge available to all the people. This book supplies the practical information which the future citizen will wish to transform into intelligent action.

Every effort has been put forth to make the book attractive as well as truthful. The text is written in simple English which can be easily read and understood. The illustrations are largely new, and are designed to visualize and vitalize the text. While nearly all the cuts are from designs or photographs made by the author, the one on page 11 is from a painting owned by the Arlington Chemical Company, and reproduced by their permission.

The demonstrations and experiments have practical bearings on hygienic living, and can be performed with the facilities which are available in every school. The observations which are suggested for the pupils to make are of matters which are of public interest in every community. The whole plan and execution of the book is in accordance with the best pedagogical standards.

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GENERAL HYGIENE

BODY AND MIND WORKING TOGETHER PERFECTLY

CHAPTER I

THE STUDY OF HYGIENE

Body and Mind. — The body is a living machine, and the mind is the engineer that controls it. The body is useless without the mind, and the mind can do nothing except by means of the body. The two must work together. When either one is out of order, the other also suffers.

One of the greatest of all the differences between a man and a tree is that a man has a mind, while a

tree has none. A tree grows in the way in which the soil, the weather, and other trees compel it to grow. But a man can use his mind to choose his home, his food, the air which he breathes, and the work which he does. He can avoid those things which will harm his body, and can do those things which will keep it strong and sound. If a person's body is in good order, we say that he is *healthy*.

The Joy of Health and Strength. — The mind takes delight in directing the actions of a sound body. A healthy boy runs for the fun of running fast, and climbs hills and trees for the pleasure of using his strength. He studies difficult lessons for the joy of thinking, and puts his whole mind to a puzzle for the delight of solving it. He has no pains or other uncomfortable feelings, and he performs all his actions so smoothly and easily that he almost forgets he has a body.

Most boys and girls do not always feel bright and active, but sometimes they have aches and pains in their bodies, and are too weak to work or play or think. When they feel like this, they are either overtired or sick.

Is Sickness Necessary? — People used to think that sickness was necessary. They supposed that diseases were caused by bad weather and by mighty powers in the air or ground, just as they supposed storms and earthquakes were caused. They thought that sickness could no more be prevented than rainy days.

Painting by W. Granville-Smith

STORM AND SICKNESS

A doctor's visit during a snowstorm. It was formerly supposed that bad weather was the principal cause of sickness.

Now we know that most forms of sickness come from causes which can readily be prevented, such as dirt, spoiled food, foul air, and wrong eating. A school child can understand how the common forms of sickness are caused, and how they may be prevented.

Progress in Health Matters. — In the United States there are always over a million persons who are sick. About two hundred thousand doctors are occupied in caring for them. The expenses of the sickness and the value of the time lost by the sick are at least a billion dollars a year. But no one can estimate the suffering and anxiety which are borne by the sick and their friends.

There is not so much sickness among civilized nations

now as formerly. We know this from a study of the records of deaths, and from the history of epidemics.

1. The death rate of a country is the number of persons dying each year in every thousand inhabitants. The governments of all civilized lands have long been keeping records of all persons who die in those countries. Before the year 1800, about fifty or sixty persons in every thousand inhabitants died each year in England, Germany, and the United States. Now, in these countries, only about fourteen persons die in every thousand inhabitants. But in India the death rate is now as high as it was in England a century ago. This is because the people of India are as ignorant of health matters now as the people of England were a century ago.

The average age at which persons die in civilized lands is now nearly double the average age at which they died a century ago. The tombs and mummies of ancient Egypt show that the Egyptians died at an average age of about twenty-two years. In the city of Geneva, Switzerland, the average age of persons dying in the year 1600 was twenty-one years; in 1700, thirty-two years; in 1800, thirty-eight years. Now, the average age of those dying in the United States is over fifty years. But in India and Russia the average age at death is now about twenty-five years, or about the same as it was in ancient Egypt. The people of those countries which are the most advanced in civilization and knowledge live about twice as long as the people of the less civilized lands.

MAN-MADE CAUSES OF SICKNESS

Garbage and sewage at the back door of a restaurant. It is now known that most human sickness comes from unsanitary conditions which are made by man himself.

2. A disease which spreads through a whole town or country is called an *epidem'ic* or a *pestilence*. The people of olden times were always in fear of war and pestilence. Thousands of men were killed each year by useless and cruel wars, but millions of men, women, and children were killed by diseases which are now seldom seen. In England in the fourteenth century, half of the population died from the plague in a single year. One hundred and two English colonists landed at Plymouth, Massachusetts, in December, 1620, and before the next spring fifty-two of them had died from what was probably typhus (tī′fus) fever. In 1879 one tenth of the inhabitants of the Philippine Islands died from cholera (kŏl′er-a). The plague, typhus

fever, and cholera are now almost unknown among most civilized peoples, but these diseases still go on in India and other less advanced lands. Now and then a few cases reach the United States, but the diseases do not spread because great care is taken to check them.

Cause of Epidemics. — The great epidemics of olden times were spread in very simple ways, and could easily have been prevented. The plague was spread by rats and fleas which swarmed over the thatched roofs and mud floors of the huts of the people. About the year 1900 the plague was brought to San Francisco by rats that came on ships from foreign lands; but the disease was stopped by making the foundations and cellars of the buildings ratproof, so that the animals could not find hiding places.

Typhus fever is caused by body lice and spreads among people who are overcrowded. This accounts for the large death rate among the colonists of Plymouth, who were badly overcrowded both on their ship and in their houses, and who had no proper means of bathing and of removing lice, and no way of separating the sick from the well. To-day, there is hardly a place in the United States where people have to live in the way the colonists lived, and therefore typhus fever is almost unknown in this country.

Cholera is spread principally among those who drink impure water. In 1832 an epidemic of cholera broke out in New York, and all the people who could get away from the city left it in terror. At that time the drink-

THE CROTON AQUEDUCT OVER THE HARLEM RIVER

This aqueduct, completed in 1840, brought pure water to the city of New York, and ended the danger of cholera.

ing water was drawn from wells which were dug along the edges of the streets, and into which slops and garbage thrown upon the ground, could drain. Therefore people were made ill from drinking the impure water from these wells. In 1840 pure water was brought to the city through the Croton aqueduct, and since that time the people of New York have not been in real danger of cholera.

These examples are given to show the simple nature of the causes of most diseases, and how they are in our control. It is not nice to have rats in our houses; it is not fashionable to be dirty; and we are ashamed to have a bad odor about our clothes or houses. But the feelings which well-bred persons have about dirt and bad odors are not founded merely upon style and show.

Failure to keep rats and other vermin out of our houses, and failure to keep clean, would mean sickness and death now, just as in olden times. You may prevent a great deal of sickness by doing the simple things which every polite and thoughtful person in a modern community is expected to do.

Diseases of the Present. — Lep′rosy, plague, typhus fever, and smallpox were formerly extremely common in all civilized lands. Now, they seldom occur. Yellow fever and malaria have been wiped out of Panama simply by the extermination of the mosquitoes there. But a great deal still remains to be done. Only about one third of all deaths in the United States are due to old age, and over half are caused by diseases which may easily be prevented. Typhoid (tī′foid) fever is still a common disease, and *colds* are extremely common. Tuberculo′sis is now so common that it is called the *great white plague*, and one tenth of all deaths among white races are due to it. We think it is a terrible thing that one tenth of the people of the Philippine Islands should have died from cholera in 1879, and yet one person in every ten who now live in the United States will die from tuberculosis, unless a great deal more is done in the near future than has been done in the past to prevent the disease.

Helping Each Other to Keep Well. — You cannot keep well by thinking of yourself alone. You must think of the health of others in order to protect your own health. If you carelessly allow some one to catch

tonsillitis (tŏn-sĭ-lī′tis) from you, he may give the disease to a third person, who may give the disease back to you a month or two after you recover from your first sickness.

You will often be soiled with dust from streets over which diseased persons and animals have scattered the germs of sickness. You will often breathe air which the sick have breathed, and will often buy food which has been handled by unhealthy persons. What others do will affect your own health, and what you do will affect the health of other persons. You are only one among hundreds of the inhabitants of a town, but the healthfulness of your town will depend on what each separate inhabitant does. When you help others to keep well, you also help yourself to be healthy.

Teaching the Care of Health. — A little child learns a great deal about the care of his body from his parents. When he goes to school, he learns more about its care from his teachers, and from the books which he studies. Later in life he learns still more from the advice of doctors, from public lectures, and from articles in books, newspapers, and magazines.

Public schools are among the best of all means for teaching the preservation of health. Most states now have laws that every public school shall teach its pupils how to take care of their bodies, and how to prevent diseases. If all boys and girls will learn to do their part in the promotion of health, the next generation of men and women will be a vigorous, happy race. Colds

and tuberculosis will be as rare as leprosy is now. Nearly all will live to a ripe old age, and sickness and pain will be almost unknown. No one will feel that life is a burden, but all will feel the joy that comes from health and strength (p. 10).

Hygiene. — The study of keeping the body in good health is called *hygiene* (hī′jĭ-ēn). In it you will study such subjects as bathing, eating, drinking, clothing, breathing, exercise, and sleep.

Hygiene also includes the study of the methods and conditions by which diseases are prevented. It therefore treats of such subjects as pure food, wholesome drinking water, fresh air, and the disposal of sewage.

Anatomy and Physiology. — Before you can understand the care of the body, you must know something about the structure of its machinery, and how it does its work. The study of the structure of the body is called *anat′omy*, and the study of its work and action is called *physiol′ogy*. You must study the anatomy and physiology of each part of the body in order to understand the care of it.

QUESTIONS

What are some of the signs of good health?

What are some of the signs of poor health?

What effect does sickness of the body have upon the mind?

About how many persons in the United States are sick at one time?

About how much money does sickness cost the people of the United States each year?

Give some reasons for thinking that there is less sickness now than formerly.

What is the average death rate in the United States?

What is the average length of life in the United States?

What is an epidemic?

Name some epidemics which used to be common, but now seldom occur.

What are some of the reasons why deadly epidemics no longer occur?

Name some deadly diseases which are now common.

How does a person protect his own health when he helps others to keep well?

What is hygiene?

What is physiology?

What is anatomy?

What is the object of teaching hygiene in schools?

For the Teacher. — The object of the study of hygiene is to cause the pupils to desire to maintain the machinery of their bodies in an efficient working state. Call attention to the dangers to which early men were subjected: — as storms and cold weather; wild animals and savage men; famine and war. Describe the means by which these dangers have been lessened.

Epidemic diseases were the next great dangers which threatened the existence of the human race. Many of these have been conquered, but others still remain, and apparently new diseases appear. Modern modes of life bring new dangers from speeding automobiles, whirling machinery, and the close association of crowds.

While great progress has been made in the past, yet still greater will be made in the future, if every pupil is instructed in the working of his body machinery and the means of keeping it in good order.

CHAPTER II

ORGANS AND CELLS

Life and Growth. — The food upon which the body lives has no life, but it becomes living blood, flesh, and bone in the body. After remaining alive for a few days or weeks, the living flesh becomes worn out and is changed back to dead and lifeless forms, and new flesh is formed to take its place.

The constant building up of worn-out parts of the body is what is called *life* and *growth*. Lifeless things change and go to pieces, and cannot build themselves up again. Living things are said to be alive because they build themselves up as fast as they wear out.

The actions of growth and repair are only slightly under the control of the mind, and so go on while a person is asleep even better than they do while he is awake. The same kinds of action go on in a tree, which has no mind at all.

Division of Labor in the Body. — Each action of the human body takes place in a particular part. One part of the body prepares food, another supplies air to all the rest of the body, other parts carry the food and air through the body, and others get rid of the worn-out food and flesh. A part of the body which has a particular work to do is called an *organ*.

Organs of Digestion. — The action of changing food to forms which living flesh can use is called *digestion.* There are five principal organs of digestion: 1, the mouth; 2, a bag, called the *stomach*, which receives the food when it is swallowed; 3, a long tube, called the *intestine* (ĭn-tĕs′tĭn), in which the food is dissolved; 4, a mass of flesh, called the *pan′creas*, in which a liquid is prepared for dissolving the food; and 5, a large mass of flesh, called the *liver*, in which food is made a part of the blood.

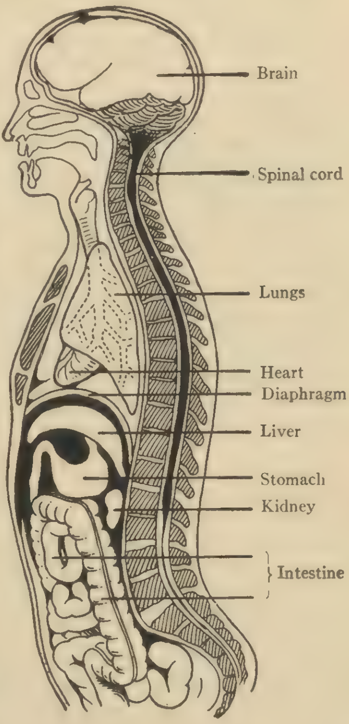


DIAGRAM OF THE POSITION OF THE PRINCIPAL ORGANS OF THE BODY

Organs of Respiration. The body cannot work, or even live, unless a constant supply of *oxygen* (ŏk′sĭ-jen) from the air reaches every part. Breathing, and the changes produced by the oxygen in the body, are called *respiration.* The principal organs of respiration are the *lungs.*

Organs of Circulation. — Blood carries oxygen and digested food through all parts of the body, and its flow

is called the *circulation*. There are two principal organs of circulation: 1, a pump, called the *heart*, which keeps the blood in motion; and 2, a vast number of tubes, which conduct the blood through the body.

Organs of Excretion. — Getting rid of worn-out substances is called *excretion*. There are three principal organs of excretion: the kidneys, the skin, and the lungs. The liver and the intestine are also important organs of excretion.

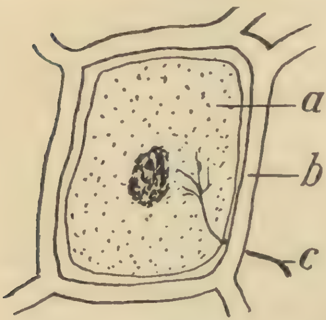


DIAGRAM OF A COMPLETE UNIT OF LIVING MATTER

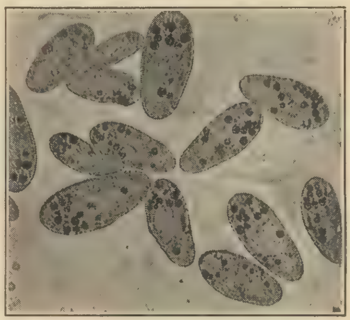
a, a cell; *b*, a blood tube which brings food and oxygen to the cell and carries away its waste matter; *c*, a nerve which carries messages between the cell and other parts of the body.

Organs of the Nervous System. — All the parts of the body are made to help one another, and to work together, by means of the nervous system. There are three principal organs of the nervous system: 1, the *brain*, situated in the top of the head; 2, the *spinal cord*, situated in the backbone; and 3, long strings of flesh, called *nerves*, which extend from the brain and spinal cord to all parts of the body.

Organs for Voluntary Work. — There are two organs for doing voluntary work: 1, the brain, which does the work of thinking; 2, a large number of bundles of lean meat, called *muscles*, which produce motions. Stiff

rods and plates, called *bones*, support the soft flesh and assist the muscles to produce nearly all the voluntary movements of the body.

Cells. — An organ is not like a lump of clay which is the same throughout its whole mass, but it is made up of microscopic units of living matter, called *cells*, which carry on all the work of the body. The cells are like separate animals which form a perfectly trained army under the control of master cells in the brain and spinal cord. They are supplied with food and oxygen by the blood; and they work for the benefit of the whole body as they are ordered by the nervous system. A complete unit of living matter in the human body consists of three parts: 1, a cell; 2, a blood tube from which the cell gets its food and oxygen; and 3, a nerve which tells the cell when and how to act.



PARAMECIUMS

(Magnified 100 times.) Each paramecium is a complete animal consisting of a single cell.

Cells in Lower Animals and Plants. — All animals and plants are composed of cells. In the lowest forms of living beings each animal and plant is composed of a single cell. A common one-celled animal is called the *slipper animal'cule*, or *parame'cium* (-shĭ-um). It is microscopic in size, and is found in stagnant water.

Place a handful of hay or dry grass in a jar of water, and leave the jar in a warm room. After two or three weeks the water will usually contain great numbers of tiny white specks, each of which is a paramecium. If you look at a drop of the water with a microscope, you can see the shape and structure of the animals as they move rapidly through the water.

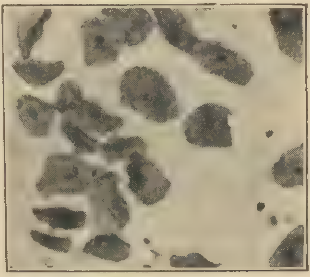

THREADS OF POND ALGÆ
Each thread consists of oblong cells joined end to end.

Collect some of the green, silky threads which float on still ponds, or grow on sticks and stones in the water. These threads are green plants called *algæ* (ăl′jē). Examine a few of the plants under a microscope. You will see that each plant is a thread which consists of a single row of oblong cells joined end to end.

All higher plants and higher animals, such as wheat or a cat, consist of masses of cells.

Size and Shape of Cells. — The different kinds of cells in the human body vary in size and shape, but not one of them is large enough to be seen with the naked eye. If you scrape the skin with a knife, you will get a white powder which looks like flour. This powder consists of cells from the outer covering of the skin. If this powder is examined with a microscope, the separate

cells appear like flat scales. Cells scraped from the inside of the cheek look nearly the same. These cells measure from one five-hundredth to one one-thousandth of an inch across, and are extremely thin.



CELLS FROM THE INSIDE OF THE CHEEK

(Magnified 100 times.) These are cells of the kind called *epithelial*.

A muscle cell is shaped like a string, and is about one five-hundredth of an inch in diameter and about one fiftieth of an inch in length. A blood cell is round and almost flat, and measures about one three-thousandth of an inch across. If you put a bit of flesh under a microscope, you can tell from what organ it came by noticing the size, shape, and arrangement of its cells.

How Cells Grow. — Most of the cells of a baby's body are of the same size and shape as the cells of a grown man, but there are not so many of them. A child does not grow by making the cells of its body larger, but by making their number greater.

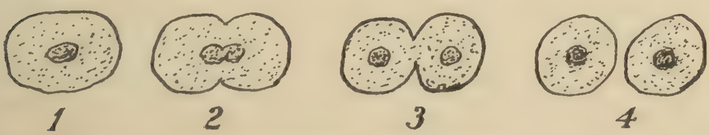
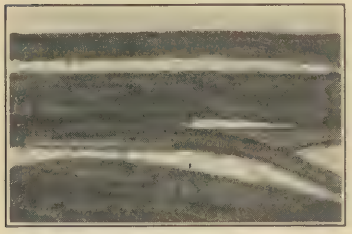


DIAGRAM OF CELL DIVISION

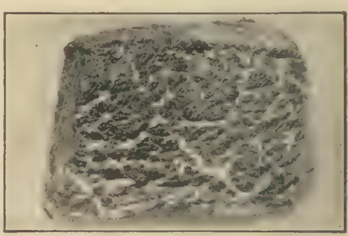
After a cell reaches its full size, it may split into two parts, beginning with its nucleus.

A cell consists of two parts: 1, a soft jellylike substance, which forms the greater part of the cell; and 2, a darker bit of matter, called the *nu'cleus*, situated near the center of the cell. After a cell reaches full size, its nucleus may divide into two parts, and the rest of the cell then splits itself in half, forming two new cells, each containing half of the old nucleus. Thus a young cell is just half the size of a full-grown cell, but it is like a full-grown cell in all other respects.



Connective Tissue Between Muscle Cells

(Magnified 100 times.) The connective tissue is white, and the muscle cells are dark.



Bundles of Muscle Cells in Beefsteak

(Natural size.) These bundles are cut across. The connective tissue is white.

Connective Tissue. — A group of cells that look and act alike is called a *tissue* (tĭsh'ū). The working cells of every organ are held in place by a tissue called *connective tissue.* These cells are small, and have long, slender arms which are tough and strong. These arms extend around and between the cells and hold them in place. If you examine the end of a piece of beefsteak, you will find a white network of tough connective tissue lying between red bundles of soft muscle cells.

Some connective tissue is found in every part of the body. It forms the greater part of the skin.

Epithelial Tissue. — The whole skin is covered with cells which are like soft scales. These are called *epithelial* (ĕp-ĭ-thē′lĭ-al) *cells*, or *epithe′lium*. They protect the soft and delicate flesh under them.

Glands. — The skin is always moist with a liquid called the *sweat*, or *perspiration*. The sweat comes

Diagram of a Gland

a, cells of epithelium on the surface of an organ; *b*, cells of epithelium which line the tubes of the gland; *c*, connective tissue which supports the gland cells.

from pores, which are the openings of deep, narrow tubes extending into the skin. Each tube is lined with cells of epithelium, which extend down the tube from the surface of the skin. The use of the cells of epithelium in the tube is to form the sweat or perspiration out of material brought to them by the blood.

A tube composed of cells of epithelium which form a substance out of the blood, is called a *gland*. The

substance which a gland forms is called a *secretion.* Sweat glands are found in the skin on nearly every part of the body.

The kidneys, liver, and pancreas are glands. They are composed of tubes of epithelium which either manufacture substances for the use of the body, or take waste substances from the blood.

The stomach and intestine contain glands which secrete digestive juices, that is, liquids which help to change food into liquid form.

Nature of the Processes of Life. — Men used to think that the processes of life were carried on by what they called *vital spirits*, and that sickness was caused by evil spirits which made their home in the sick person's body for a time. Now it is known that the work which goes on in most parts of the body is done by the same means and in the same manner as work is done in a workshop or laboratory. For example, food may be digested in a bottle in the same way as it is digested in the stomach.

There are exact means of knowing the changes which take place in the body, both in health and in disease. The study of the living actions of the body has led to the discovery of the causes of most forms of sickness and of the means of keeping the body healthy. One does not need to be a physician in order to understand these changes; and it is the duty of every person to learn how to run the machinery of his body and how to give it the proper care.

QUESTIONS

Name one great difference between bodies which are living and those which are lifeless.

Name the two principal voluntary actions which take place in the body.

Name some involuntary actions which take place in the body.

What is an organ?

Name the principal organs of digestion; of circulation; of excretion; of the nervous system; of voluntary work; of respiration.

What are cells?

Describe a complete unit of living matter in the body.

Give the sizes of several different kinds of cells.

How do cells multiply in number?

Describe an animal which consists of a single cell.

Describe a plant in which cells may be readily seen.

What is a tissue?

What is *connective tissue?*

What is *epithelial tissue?*

Describe a gland.

What is a *secretion?*

Name some glands.

Name a living process which may be imitated in a laboratory.

For the Teacher. — This chapter deals with two fundamental biological concepts:

1. The division of labor in the various organs of the body.
2. Units of living matter — the *cells*.

Every piece of machinery made by man, such as a watch or a printing machine, consists of working units which may readily be seen. The units, or *cells*, of living things are microscopic in size, and yet they are remarkably alike in all forms of living things. The cells of the liver of a fish, for example, are strikingly like those of man. There is also a striking uniformity in the living actions of all cells. A study of single-celled animals illustrates the working of human cells.

It is correct scientifically to consider the human body as made up of armies of living cells, all working for the common good under the control of governing cells in the central nervous system.

CHAPTER III

COMPOSITION OF THE BODY

The Substances of the Body. — The substances of which the body is composed are constantly changing. Over a pound of flesh wears away each day, and new flesh is formed in its place.

The body is composed of five different kinds of substances. Their names are water, minerals, proteins (prō′tē̇-ĭnz), fats, and sugar. It is important for you to remember them and to understand what they are, for every act of the body produces a change in them.

Water. — Water is the most abundant substance in the body. Three fourths of the weight of the flesh, and one fifth of the weight of bone, is water. It does not exist pure and alone in any part of the body, but it is always found mixed with other substances, which it softens and dissolves so that the processes of life can go on.

Minerals. — If a person's body were burned, about one twelfth of it would be left as ashes. The ashes are mineral substances which are mixed with the flesh, blood, and bone of every part of the body. The most abundant of the minerals is lime. Most of the lime is found in the bones, but some is found also in the flesh

and the blood. Salt, soda, potash, and iron are other important minerals which are always found in the body.

Protein. — Protein is a substance which may be found in every living thing. An older name for it is *albu'min*. All life is carried on by means of it, and without it there can be no life. Growing cells consist principally of protein and water, with a little mineral matter. The protein in the body weighs about one eighth as much as the whole body.

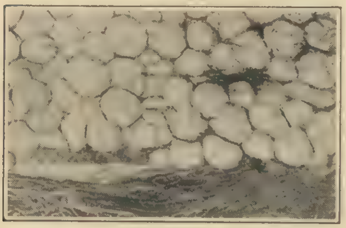
Pure protein is a solid substance which is like the dried white of an egg. It does not exist alone and in a pure form in any part of the body, but it is always found dissolved in water and mixed with a little mineral matter. When we speak of the protein of the body we mean a liquid or jellylike mixture of protein, water, and minerals.

Liquid protein may be changed to a solid form by heat or other means. This change from a liquid to a solid form is called *coagulation* (ko-ăg-ū-lā'shun). Examples of the coagulation of protein are the hardening of the white of an egg when it is boiled, the curdling of milk when it sours, and the clotting of blood after it flows from the body.

Fat. — About one tenth of the body consists of fat, which is like lard or tallow. Collections of fat lie under the skin, and between the bundles of muscles, and around many of the organs of the body. Fat itself is not a living substance, but what is called fat meat

consists of tiny pockets of living connective tissue filled with fat. The fat of a living body is not solid as it is in cold meat, but during life the heat of the body keeps it in a liquid form.

The use of fat is to keep the body warm, and to furnish it with strength to work. When a person cannot eat food, his body uses up its own fat as food. It then loses weight and becomes thin. Fat is food stored up to be used when the body cannot get other food.



FAT TISSUE

(Magnified 100 times.) Fat is stored in pockets of connective tissue.

Sugar. — About eight ounces of substances which are like sugar are found in the liver and muscles of a grown person. Their use is to supply the body with heat and strength.

Food. —The water, minerals, proteins, fats, and sugar of the body come from the food which is eaten. Our food consists of the same five kinds of substances. The body of a grown person takes about seven pounds of them daily, and it must give them off in nearly the same amounts, for its weight changes very slowly. But before getting rid of them, the body changes some of them by a process called *oxida'tion*, which is like the burning in a fire.

Oxygen. — No person can live unless he takes air into his body several times each minute. The part of

the air which the body uses is called *oxygen*. This substance forms about one fifth of the whole air. The quantity of oxygen which the body takes from the air each day weighs more than all its daily food except water. The oxygen passes through the body with the blood, and joins itself to food and flesh. The process by which oxygen is joined to another substance is called *oxidation*.

Oxidation in a Fire. — A fire is an example of oxidation. Burning is the process by which oxygen is united with fuel, such as wood, coal, or oil. When wood burns, more than its own weight of oxygen unites with it quickly and forcibly. While the two substances are uniting, they produce a great deal of heat. When the oxygen and the wood are joined together, they become smoke and ashes.

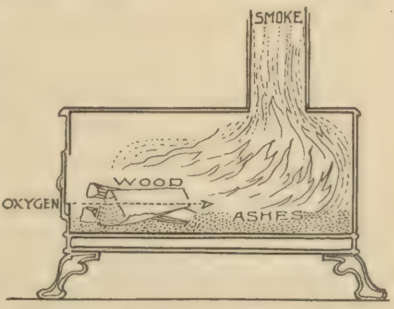


DIAGRAM OF OXIDATION IN A STOVE
The same process goes on in the body, only much more slowly.

Heat and Oxidation. — Oxidation in the body is the same kind of process as that which takes place when wood burns in a stove, but it takes place slowly and gently in the body. It produces the same quantity of heat that burning the food or flesh in a stove would have produced. The heat produced by oxidation keeps the body warm.

Power from Oxidation. — Oxidation also gives the body power and strength to do work, just as the burning of wood and coal supplies power to a steam engine. All the strength of the body to walk, or speak, or think, or to do anything else, comes from oxidation. When we say that the body wears itself out by working, we mean that it oxidizes its flesh and food, just as a locomotive burns up coal when it runs.

Worn-out Flesh. — The worn-out substances and waste matters of the body are mostly food and flesh which have been oxidized. They are composed of the same kinds of substances that are in the smoke and ashes of a fire.

The protein, fat, and sugar of food and flesh are composed of the same simple substances as those of which wood and coal are mainly composed. The names of two of these substances are *carbon* and *hydrogen* (hī'dro-jen). The oxidation of these two substances supplies most of the heat and power of the body.

Carbon Dioxide. — Carbon is usually a solid. A common form of it is charcoal. When oxygen unites with it, the two substances become a gas called *carbon diox'ide*, or carbonic acid. This is the same gas that is put into soda water to make it bubble and foam. Carbon dioxide is produced in fires by the oxidation of the carbon of the fuel, and is found in the smoke. It is also produced by the oxidation of the carbon in flesh and food, and is given off from the body by the lungs.

If you put one end of a tube into a glass of clear limewater and blow through the other end, the carbon dioxide from your breath will turn the limewater milky. This is a proof of the presence of carbon dioxide.

Manufacture of Water in the Body. — Hydrogen is a gas, and is one of the principal substances in the gas which is burned in houses. It is also abundant in wood, coal, and oil, and in a person's flesh and food. When oxygen unites with hydrogen, the two gases become water. When a cold lamp chimney is put upon a lighted lamp, some of the water which is formed by the burning hydrogen of the oil may be seen on the inside of the chimney. Nearly a pint of water is formed each day in the body of a grown person by the oxidation of the hydrogen of food and flesh.

Other Waste Matters of Oxidation. — *Ni'trogen* is a simple substance found in protein. When protein is oxidized, two substances are formed which contain the nitrogen — *u'rea* and *u'ric acid.* These two substances are given off from the body by the skin and kidneys.

When food or flesh is oxidized, its minerals are left behind, like the ashes of burned wood. They too are given off by the skin and kidneys.

If the oxidation in the body is disturbed in any way, as by improper eating or breathing, the waste substances will be far more harmful than the carbon dioxide, urea, and uric acid which are naturally formed. These waste substances are the cause of much of the pain and weakness during most forms of sickness.

QUESTIONS

Of what five kinds of substances is the body composed? What proportion of the body does each of these furnish?

Of what are the ashes of burned flesh composed?

Describe protein. Give an example of protein.

How is fat stored in the body?

What is *oxygen?* What is *oxidation?*

Describe the process of burning in a fire.

Compare oxidation in the body with a fire.

Of what use is oxidation in the body?

Of what does worn-out flesh in the body consist?

What is *carbon?* What is *hydrogen?*

What substance does each produce, when it is oxidized in the body?

What substances are formed by the oxidation of substances containing nitrogen?

What are some of the effects of improper oxidation in the body?

For the Teacher. — The object of this chapter is twofold:

1. To show the nature of the substances of which the body is composed.
2. To show the nature of oxidation.

The substances of which the body is composed are constantly being shed and new substances are formed into living flesh in their places. Almost the only substance which is not constantly renewed is that which composes the teeth. Many of the living actions of the body are like chemical actions which can be imitated in a laboratory.

The essential process in the destruction of living flesh is that of oxidation, and is similar in most respects to that which takes place in a fire. The steps in the process of oxidation will be traced in more detail in the chapters on respiration, heat, and excretion. In this chapter teach the following topics:

1. The substances which unite in the process of oxidation.
2. The substances which are formed by the union.
3. The heat and power which are developed by the process.

The following outline will be helpful. Food and flesh are composed of four principal substances — 1, carbon; 2, hydrogen; 3, nitrogen; 4, minerals. Several ounces of oxygen enter the body daily and unite with the carbon, hydrogen, and nitrogen.

Carbon + oxygen = carbon dioxide
Hydrogen + oxygen = water
Nitrogen + oxygen (+ carbon + hydrogen) = urea and uric acid

CHAPTER IV

DISEASE GERMS

Infectious Diseases. — Diseases and disorders of the body are divided into two classes:

1. Those which spread from the sick to the well, such as measles, scarlet fever, and colds.

2. Those which do not spread, such as indigestion and broken bones.

Diseases which are caught by one person from another are called *infec'tious* diseases. They are also called *catching*, or *contagious*, or *communicable* diseases. They are caused by living plants or animals, called *disease germs*, which grow in the body. When a disease is caught, a few of its germs enter the body and multiply to countless millions. More than half of the deaths which occur before old age are caused by infectious diseases. Nearly all fevers and colds are caused by disease germs.

Decay. — Infectious diseases in living things are like the processes of decay in lifeless matter. A living thing preserves itself; but after it dies, it usually becomes soft and goes to pieces, unless great care is taken to preserve it. The natural process of destruction is called *decay*, or *rotting*.

The final result of decay is the oxidation of dead matter and the formation of the same substances that would have been formed if the decaying matter had been burned. For example, the body of a dead animal that is buried in the ground becomes oxidized and changed to gases and ashes. When the process of decay is complete, the oxidized products are in such a form that plants can use them as food, and can build the particles again into living forms. The fertilizers which farmers spread upon their land consist principally of decaying substances. Decay is as necessary as growth, for if dead animals and plants did not decay, their remains would soon cover the whole earth.

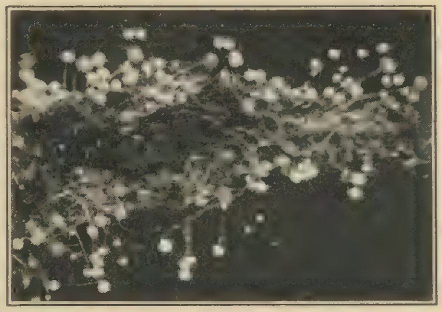
PHOTOGRAPH OF MOLD THREADS
(Magnified 100 times.)

The processes of decay are caused by three groups of living things, called *molds*, *yeasts*, and *bacte'ria*.

Molds. — Common molds produce a furry or wooly coating on the substances on which they grow; but the fur on the surface is only the fruit of the mold plants. The greater part of a mold plant consists of slender threads which grow beneath the surface of the substance, and

are so small that the separate threads can scarcely be seen with the naked eye. Under a microscope the threads appear as long cells joined end to end into strings. Mold threads multiply rapidly, and cause decay in substances in which they grow.

Mold Spores. — Full-grown mold plants send up fruit stalks above the surface. Each stalk is tipped with a tiny knob which is filled with tiny balls, called *spores*. Each spore is a kind of seed which may grow and produce a mold plant. The spores float away in the air and grow on substances on which they fall. They are scattered everywhere, and so molds are found wherever there is the proper soil on which they can grow. Molds have important effects on the health and comfort of persons, for they cause food to spoil and wood to decay; and wherever they grow, disease germs may usually grow also.

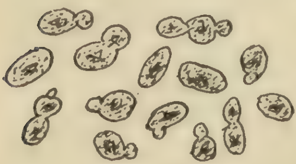


Photograph of Mold Stalks and Spore Cases

(Magnified 10 times.)

Yeast. — A common process which is like decay is that caused by yeast, and is called *fermenta'tion*. Yeast plants are small, oval cells. A yeast cake that is used in making bread consists of millions of dried

yeast plants mixed with flour or meal. When the yeast cake is placed in water which contains sugar, the cells grow rapidly and new cells spring from the sides of the old ones, like buds from a twig. In this way yeast plants increase in numbers with great rapidity. Growing yeast plants change sugar to alcohol and carbon dioxide, or carbonic acid gas. The gas rises through the liquid in bubbles which look like bubbles of steam in boiling water. It is for this reason that the process is called fermentation, from the Latin word which means boiling.



YEAST PLANTS

Diagram of growing yeast cells, showing the buds which spring from the full-grown cells. (Magnified 500 times.)

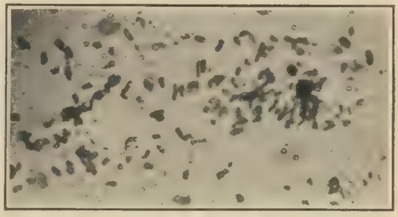
Yeast cells may remain alive after they are dried. They may float in the air as dust, and may grow again when they fall into fruit juice or other liquid which contains sugar. Fruit juice usually ferments within a few hours or days because of the yeasts which fall into it.

Bacteria. — The most common forms of decay are caused by tiny living things called *bacteria*, which are the smallest living things that are known. When they are examined under a powerful microscope, most of them appear like the dots and dashes on a printed page.

How to See Bacteria. — An easy way to find bacteria is to soak a handful of hay in a bottle of water. After a few days examine a drop of the water with a micro-

scope, using its greatest magnifying power. You will see great numbers of bacteria that appear like faint dots and dashes in constant motion.

How Bacteria Grow. — Bacteria increase in number by the simple process of each one dividing itself into two bacteria, just as if it had been broken in two. Each of the two is as complete and separate a bacterium as the single plant was before it became divided. Within an hour each of the two may reach its full size and may itself divide into two, thus making four bacteria. Each of the four may divide within another hour, making eight. If this goes on for twenty-four hours, there will be sixteen millions of bacteria in place of only one, and yet they are so small that the whole of them would form a lump no larger than a small grain of sand. At the end of two days the bacteria would multiply to two hundred and fifty-six millions of millions, and would fill a pint measure. At the end of three days there would be enough bacteria to load an ocean steamship. Bacteria often multiply at this rate for a few hours, in substances which decay or putrefy readily, but they soon use up all the food which they can reach, and their further growth is then impossible.



BACTERIA IN HAY WATER

(Magnified 1000 times.) Bacteria are the principal causes of decay.

Where Bacteria are Found. — Since bacteria multiply with great rapidity, they are the most abundant of all living things. Countless millions are found in all kinds of decaying substances, and in the soil. Water usually contains a few of them, and every object is sprinkled with them. About a thousand bacteria are found in each drop of milk when it is fresh and clean, but a million may sometimes be found in each drop after it has stood for a day in an ordinary pantry.

Of all living things, bacteria are the hardest to kill. Drying or freezing does not kill most of them, but only stops their growth until they become wet and warm again. When dried, they are often blown away by the wind, and so bacteria are found in most dust, and on everything on which dust falls.

Canning Food. — The processes of decay and of fermentation, as in the spoiling of food, are catching or infectious. A decaying apple will cause decay to begin in another apple which it touches; and a yeast cake will cause fermentation to start in bread dough or fruit juice into which the yeast cake is put.

A food or other substance will not decay or ferment or turn sour if there are no living molds, yeasts, or bacteria in it. The process of preserving food by canning consists of boiling the food so as to kill all living things in it, and sealing the food in air-tight cans so that no more mold spores, yeasts, or bacteria can enter it. Food canned in this way will remain fresh for months or years.

Canned food often spoils because of failure to boil the jars and covers in order to kill the molds on them. A good way to can fruit is to put it into jars and put the covers on loosely. Then boil the jars and fruit together, and, lastly, fasten the covers on tightly.

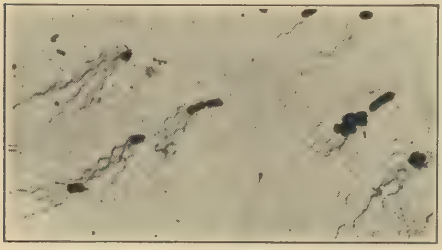
FOOD PRESERVED BY CANNING

Heating kills the molds, yeasts, and bacteria, and sealing the cans prevents more from entering the food.

Useful Bacteria. — Many kinds of bacteria produce substances which are pleasant to the taste or smell, or which are useful to man. Bacteria change cider to vinegar. They are necessary in making butter, for butter made from cream which contains no bacteria would taste about like lard. Farmers depend on bacteria to cause substances to decay and enrich the soil, and cities often depend on bacteria of decay to destroy their sewage. Over a thousand kinds of

bacteria are known, and nearly all of them are useful to man.

Bacteria in the Body. — Many kinds of bacteria which produce offensive decay often grow on the skin. In the mouth, bits of food, dead skin, and the moisture of saliva form a good soil in which many kinds of bacteria may flourish and cause decay and a bad breath. Bacteria are the cause of decay in teeth. They may grow in the dead scales of a dirty skin and cause the bad odors of an unwashed body. They may grow abundantly in the intestine, and be the cause of many forms of indigestion.



Typhoid Bacteria

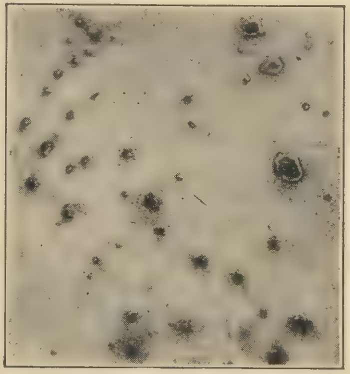
(Magnified 2000 times.) A few of these germs taken into the body grow and multiply, and produce severe sickness.

A few kinds of bacteria may grow in living flesh. These are the causes of most kinds of infectious diseases.

List of Infectious Diseases. — The common diseases which persons may catch from others who have the same diseases number about twenty. Among those of which bacteria have been proved to be the cause are diphtheria (dĭf-thē′rĭ-ȧ), typhoid fever, tuberculosis, grippe, pneumonia (nū-mō′nĭ-ȧ), lockjaw, erysipelas (ĕr-ĭ-sĭp′ĕ-las), and most kinds of tonsillitis, colds, and sore throat. Pimples, boils, and all other kinds of sores which give off a creamy matter are often called

blood poisoning, but they are all caused by bacteria growing in the flesh.

Other examples of infectious diseases are mumps and whooping cough, and also those diseases in which the skin becomes spotted or broken out, such as measles, German measles, scarlet fever, smallpox, and chicken pox. They resemble the diseases whose cause has been proved to be bacteria.



THE SKIN IN CHICKEN POX

The germs in chicken pox, growing in the body, cause the skin to "break out."

Other Kinds of Disease Germs. — A few kinds of infectious diseases are caused by microscopic animals which grow in the blood. Malaria is caused by a microscopic animal which one kind of mosquito leaves under a person's skin when it sucks his blood. Hydropho′bia is caused by microscopic animals which grow in the brain.

Where Disease Germs are Found. — Germs of disease do not grow naturally in the soil, or water, or air, or food. Nearly all kinds grow only in the bodies of sick persons or animals, but they may stay alive after they have left the bodies of the persons or animals in which they have grown. If a person has an infectious disease, it is because he has received living germs from some one who was sick before he was. Every person

who has an infectious disease is dangerous to others around him, unless great care is taken to kill all the germs which come from his body.

When a person has an infectious disease, some of the germs may leave his body from sores and wounds, if there are any on the skin; but very few germs leave the skin when it is clean and sound. Nearly all the germs which leave the body pass off either from the nose, or mouth, or from the intestine, or from the kidneys. If every sick person would guard these four gateways of his body, few disease germs could escape alive, and soon no one could catch an infectious disease, for all the germs would be dead.

Cleanliness. — If disease germs are not caught and killed as soon as they leave the body, they may remain alive for some time. They are found on everything which has been soiled by those who are sick with infectious diseases. They are found in dirt, filth, sewage, and garbage; in the dust and foul air of houses and meeting places; on dirty handkerchiefs, towels, bedclothes, and soiled garments; and on forks, spoons, dishes, and other articles which have been used by the sick. The prevention of diseases depends largely upon cleanliness.

Cleanliness does not mean something hard and difficult which only a doctor can understand, but simply keeping clean in a way that a good housekeeper understands. It also means keeping back yards and kitchens clean and neat.

QUESTIONS

What are infectious diseases? Name several.

By what are infectious diseases caused?

What are molds? What are spores?

On which part of a mold plant do the spores grow?

Why does a piece of bread often become moldy a few days after it is cut?

What is yeast? What is fermentation?

What substances are produced by yeasts?

What are bacteria?

How large are bacteria?

What do bacteria look like?

Where may bacteria be found?

How do bacteria grow and multiply?

What have bacteria to do with decay or rotting?

Of what use is decay?

Name some other uses of bacteria.

Why does food keep fresh when it is properly canned?

Where do the bacteria of infectious diseases grow?

From what part of a sick person's body are disease germs given off?

Where are disease germs likely to be found outside of a human body?

What has cleanliness to do with preventing the spread of diseases?

For the Teacher. — The object of this chapter is to show the nature of the living organisms which produce most of the processes of decay and of infectious diseases. The concept of bacteria is at the basis of most phases of modern sanitation. It is introduced early in this study of hygiene in order to afford a basis for understanding the reasons for the hygienic care of the body. Among the topics to be taught are:

1. The three groups of microscopic organisms which produce the actions of decay, fermentation, and infectious diseases.

2. The infectious nature of decay and communicable disease.

3. Where disease germs are produced; how they are spread; how they enter the bodies of well persons; and how they may be kept out of the body.

4. The nature of the process of canning food.

5. The human origin of infectious diseases. Dirt, decaying substances, and impure food do not *produce* disease germs; they may CARRY the germs from the sick to well persons.

CHAPTER V

DEPARTMENT OF HEALTH

Need of a Health Department. — The prevention of disease is the duty of every individual citizen, and also of a branch of government called the department of health. An infectious disease, like a fire, may spread through a community in a great wave, called an *epidemic* (see p. 13). It is the duty of every person to respect the property, the rights, and the health of others, and to coöperate in keeping diseases from spreading. But many persons are careless and do not put themselves to the trouble of protecting others; and many are ignorant and do not know how to prevent disease germs from spreading. There is need, therefore, that one branch of government should be a department of health in order to direct the work of preventing diseases. Departments of health are organized in states, counties, cities, villages, and townships.

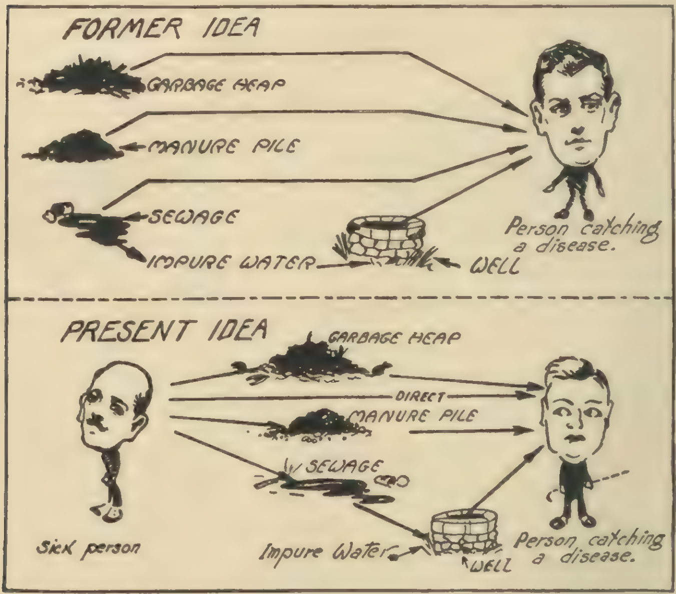
A department of health does not relieve any citizen of his duties, but it adds to his responsibilities by reminding him of his duties and compelling him to do them. The principal work of preventing diseases must be done by individual citizens. A department of health is like a good teacher in a school in which each pupil

tries his best to learn and to obey the rules of order and work. The success of the work of a department of health depends upon each citizen's efforts to obey the health laws and to follow the rules for the prevention of diseases.

History. — The modern work of preventing infectious diseases in the United States began in the years between 1830 and 1840, when the people of the larger cities began to put plumbing into their homes, and to build sewers and modern waterworks. Before that time people thought the soil, air, and water were naturally poisonous in some places and healthful in others. It was then found that diseases spread in places which had been healthful, and that wells which had produced wholesome water began to spread diseases. The cause of this change to unhealthfulness was found to be accumulations of sewage, garbage, rubbish, dirt, and filth which had resulted from overcrowding and the lack of means of carrying away the waste substances. Men believed that diseases would cease if homes and yards and streets were made as clean as the earth naturally is in uninhabited places; and so they organized departments of health, whose principal duties were to remove sewage, garbage, and other decaying substances, and to make everything clean. The result was a marked reduction in intestinal diseases, for they were often spread by sewage and water; but other kinds of diseases remained as prevalent as ever.

The prevention of diseases between 1830 and 1880

was founded on the belief that any decaying substance could produce a disease. But between the years 1880 and 1890 disease germs were studied and their origin



OLD AND NEW THEORIES ABOUT THE CAUSE OF INFECTIOUS DISEASES

It was formerly thought that any decaying substance could produce a disease. Now it is known that disease germs come from sick persons, but may be carried from them to other persons by means of sewage, or garbage, or dirt of human origin.

traced, and it was found that dirt and decaying substances did not contain disease germs, and did not produce a disease, unless they contained germs which came from a diseased person (or, in a few cases, from a diseased animal). It was also discovered that diseased persons were spreaders of diseases, and that

decaying household waste was only one means by which disease germs were spread from sick to well persons. Departments of health then extended the range of their duties, and now the principal part of their work is to find and control THE PERSONS who produce disease germs. But they also continue the work of sewage disposal, water purification, and cleanliness as actively as ever.

Public Health Work. — The care of the health of the people is the work of physicians, and is done along two lines:

1. Private practice.
2. Public health work.

Private practice consists principally in treating sick persons to whom the physicians are called. The principal work of a physician in private practice is to cure persons after they have become sick. Public health work consists in preventing sickness. It is done largely by physicians and nurses who are employed by health departments. The physicians of the departments deal principally with infectious diseases. They help private physicians to recognize diseases, and they assist in curing sickness when they are asked; but their great work is to prevent diseases from spreading. In this work it is the duty of every private physician to assist. The laws of most states require every physician to report to the health department the name and address of every person whom he treats for any infectious disease which the department may require to be reported.

Among such diseases are diphtheria, scarlet fever, and typhoid fever.

Methods of Public Health Work. — A department of health has two methods of work:

1. Compulsion.
2. Advice and persuasion.

States, counties, cities, villages, and towns have health laws for the control of diseases; and their de-

COMPULSION PERSUASION AND EDUCATION

The two methods of doing public health work.

partments of health have the power to compel all persons to obey the laws, and to arrest and punish those who disobey them. The power to compel obedience is called *police* power. Departments of health seldom use this power, but they act principally by means of advice and persuasion. A law represents the wishes of the greater part of the people of a community. If

the people will not support a health department when it tries to compel obedience, the department can do little. But physicians and nurses of health departments can usually persuade people to observe health laws, and the people are willing to obey them when they understand their meaning and necessity. Ignorance is the principal reason for disobeying health laws. A good public health worker must be first of all a good teacher in health matters.

Public Health Education. — Education in health matters is carried on along two lines:

1. Individual instruction.
2. Public teaching.

When a physician or other officer of a department of health calls on a person, he explains the reasons for the orders which he gives. Instructions in disease prevention are given to the family of every person on whom the officer calls on account of an infectious disease; every person on whom a call is made for disobeying a health rule is taught how he shall act; and inspectors give out information regarding the care of cesspools, covering food, and other health matters.

The officers of departments of health also make reports about their work and publish pamphlets and news items informing the people about infectious diseases, and giving them warning and instruction when a disease appears in a town. One of the principal lines of work of a good department of health is that of public health education.

Department of Health. — There is a health department in nearly every state, and other boards or officers for counties, or cities, or villages, or towns. Every citizen is directly under some department of health to whom he may complain and from whom he may seek advice. A department of health usually consists of a board of health, and a health officer and his assistants.

A board of health, by whatever name it may be called, is the governing body of a health department. Some of its more important duties are:

1. To appoint the officers, inspectors, clerks, and other persons employed by the department.

2. To handle the money of the department.

3. To make rules and regulations for the protection of health.

The health officer is usually a physician. He manages the health work of the department. Some of his more important duties are:

1. To receive and act upon reports which physicians and others make regarding persons who have infectious diseases.

2. To investigate complaints regarding unhealthful conditions and see that the conditions are corrected.

3. To be a leader in educating people in health matters.

The larger departments of health also employ nurses, inspectors, and clerks to assist the health officer and keep the records of the department. The Health De-

partment of the city of New York employs over two thousand persons.

Results of Public Health Work. — The people of the United States and other highly civilized countries have received more benefit from public health work than from almost any other source. Among the results are:

1. A death rate less than half of that of a century ago (p. 12).

2. Longer life for most persons (p. 12).

3. Less disease, suffering, and loss of time from sickness. Cholera, typhus fever, and plague are rare diseases; smallpox has been almost suppressed; and typhoid has been reduced to one tenth of its former prevalence.

Future Public Health Work. — Many diseases still remain to be overcome. Tuberculosis, pneumonia, colds, and other diseases of the lungs and air tubes remain unconquered, but public health workers are constantly making discoveries which promise future results even greater than those of the past.

The public health work of the past has been principally that of preventing diseases. It was formerly supposed that the human body would grow up strong and vigorous if there was no sickness or disease. But many children are born with defects which prevent their growth, and many parents are ignorant and allow their children to form bad habits of eating, sleeping, and doing other acts which prevent them from living lives of action and vigor. The public schools have already

begun the work of examining pupils, and are not only correcting their defects and bad health habits but also establishing good health habits among them. Public health work of the future will grow beyond merely escaping sickness, and will include the promotion of living with perfect strength and vigor of both body and mind.

Health of Mind and Body. — Men of olden times thought that the body was opposed to the mind. They used to starve themselves and torture their flesh in trying to weaken their bodies in order to free their minds and spirits. It is now known that the only persons whose minds are free are those whose bodies are in such perfect health that their minds are not disturbed by any unpleasant bodily feelings. The first thing to do in helping the mind of any troubled person is to make his body comfortable and healthy. One of the great duties of a government is to provide the means by which each citizen may preserve a healthy mind in a healthy body.

QUESTIONS

Give some reasons for the need of departments of health.

What are the duties of every citizen in preventing disease?

How may a citizen help the health department?

What kind of work was first done by health departments? What is the principal kind of work that is done at present?

What is the difference between the practice of a private physician and the work of one employed by a department of health?

Why is better public health work accomplished by education than by compulsion?

Describe some means of educating the people in health matters.

Of what does a department of health consist?

What are the duties of a board of health? of a health officer?

What is the name and address of the health officer to whom you would make a complaint?

For the Teacher. — Make a direct application of this chapter to the local health department of the community in which your school is located. Who is the health officer? What is his address? his telephone number?

Go to your health officer and get a set of the blanks on which cases of contagious disease are reported; and also a set of the descriptive pamphlets which he gives to the cases. Many states supply these to the health officers.

Does the health officer keep a record of all cases of contagious diseases that occur in your community? How many occurred during the past year? If a pupil in your school broke out with scarlet fever, how would you inform the health officer about the case? What would your health officer do to quarantine, or isolate, or otherwise control the case?

If your health officer should fail to do his duty, who is the higher officer to whom you would make complaint? (It may be his board of health, or a county health officer, or a state department of health. The organization of health departments varies greatly in the several states.)

Are health articles published in your local papers? Are health lectures ever given in your community? health pictures shown? health exhibits held?

Ask your health officer to come to your school and give a talk to the pupils. Merely to see the health officer will make him a real personage to them. Try to make the pupils familiar with their own health department. Without criticizing, show how the public health service could be brought up to the standard of that in the most progressive communities.

Emphasize the fact that each individual has a personal responsibility to care for his own health, and especially to form good health habits of daily living, and to do health chores in the routine daily care of his body. Show that the protection of one's own health requires that each person also shall do health chores in order to protect the health of other persons. Personal hygiene merges into civic hygiene.

CHAPTER VI

STIMULANTS AND NARCOTICS

Appetites. — Cats, dogs, and other animals are able to live healthy lives because they are born with appetites and feelings which they follow in whatever they do. Their feelings of hunger and thirst, of pain and fatigue, of joy and pleasure, and of anger and fear, are some of the guides by which they live and act.

Men have the same kind of appetites and feelings that lower animals have, and they take these feelings as their guides in what they do. But they also have their thoughts to guide them. An animal does not think, but it tries to satisfy its appetite as soon as it feels a desire for something. Men can think what will happen if they should satisfy an appetite, and they can judge whether or not it is best to do what they feel like doing. They live by means of their thoughts, as well as their feelings.

Pleasure of an Appetite. — Satisfying an appetite gives pleasure and leads us to supply the needs of the body. If eating were a painful duty, many persons would starve to death rather than take food. But eating is a great pleasure, and many persons eat too much

because they think of the pleasure of eating, and forget the needs of their bodies. Appetites are not always sure guides, for they may be false and harmful.

False Appetites. — Some persons have appetites for things which are not good for them. Many harmful substances seem to give pleasure at first, but they cause sickness a few hours or days after they have been taken. Some of these things are alcohol, tobacco, and opium. Many persons have appetites for them, and take them when they know their danger. These appetites are false, but they are often more powerful than the appetites which are true and useful. Men often yield to false appetites because they think only of their present pleasures.

Intemperance. — A person who eats too much is intemperate in his eating ; but *intemperance* usually means satisfying a false appetite for drinks which contain alcohol, and which are often called *strong drinks.* Men sometimes take a strong drink because they have an appetite for it, and do not stop to think of the harm that it will do.

There are many kinds of strong drink, but all of them contain a substance called *alcohol.* They are manufactured from liquids which contain sugar, and are made by changing the sugar to alcohol. This change is produced by means of *yeast* (p. 40).

Fermentation. — The juice which is pressed from sweet fruit, such as grapes, contains sugar, coloring matter, and flavorings. After it has stood for a few hours,

it begins to ferment. The fermentation is caused by yeast plants which fall into the juice from the air. The yeast changes the sugar to alcohol; and the juice is then an intoxicating liquor, called *wine*.

Fresh fruit juice is a wholesome food and drink, for it is fruit from which the skins and tough parts of the pulp have been taken. If the juice is heated and put into sealed cans or bottles, it may be kept for months without fermenting, just as canned food is kept (p. 42). In this way fresh grape juice, called unfermented wine, is preserved.

The juice of apples is called *cider*. This juice, if not preserved, begins to ferment within a few hours after it is pressed out, and cider which is only a few days old may contain enough alcohol to be harmful.

Other kinds of strong drink, such as beer and whisky, are made from sprouted grain in which part of the starch has been changed to sugar. Many patent medicines and so-called tonics contain a considerable amount of alcohol and are dangerous to health.

Vinegar. — If a fruit juice contains only a little sugar, it will become sour when it ferments. This is because bacteria grow in the juice with the yeast, and change its alcohol to a sour substance called *acetic* (ȧ-sē′tĭk) *acid*. After cider has fermented for some weeks, all of its alcohol becomes acetic acid, and the liquid is then called *vinegar*, from two Latin words meaning *sour wine*. A great deal of vinegar is made from the juice of grapes and apples.

Uses of Alcohol. — Pure alcohol is made by a process called *distillation*, in which the vapor from a boiling fermented liquor is caught and condensed. Alcohol is a liquid which looks like water. It will dissolve many substances which water will not dissolve, and for this reason it is largely used in manufacturing. Meat placed in it will not decay, and so it is used in schools and colleges for preserving specimens. It will burn with a hot flame without smoke, and so it is often used for heating and cooking. If mixed with air, it will explode, and so it is sometimes used in engines in place of gasoline.

There are two kinds of alcohol in common use. One kind is made from wood, for use in manufacturing; this is very poisonous if used in drink. The other kind of alcohol is made from grain, and is the kind that is used in strong drinks.

Drunkenness. — Strong drink produces two kinds of harmful effects on those who take it. One kind of harm is that which comes on within a few moments after the drink is taken. This effect is called *drunkenness*, or *intoxication*. Drunkenness is a severe sickness of both the body and the mind. It harms a person as any other form of sickness will.

The other kind of harmful effect which is produced by alcoholic drinks is a slow poisoning of the whole body and mind. This effect may come from taking small quantities of drink often, even though the person does not get drunk.

Alcohol a Stimulant. — Alcohol acts like a whip to the mind and the body. The old Romans called a whip a *stim′ulus*, and for this reason alcohol is called a *stimulant*. A whip does not make a person or an animal strong. There are far better ways of getting a man to work than by driving him with a whip, or with a stimulant.

Alcohol rouses a person up, and he may then think that his strength is increased because he feels like doing something. But the drink really disturbs him in his work, just as whipping a boy in school every few minutes would disturb him in getting his lessons. A difference between a whipping in school and a stimulation with alcohol is that the whipping causes pain at once; but alcohol dulls the mind, and prevents the harm from being felt until afterward. This is the great danger from taking alcohol, for it deceives the drinker, and makes him think that he is being helped when he is really being harmed.

Alcohol a Narcotic. — The mind of a man who is stimulated with alcohol is benumbed and cannot act right, even though it tries to do so. For this reason alcohol is called a *narcot′ic*, from a Greek word meaning to make numb.

Prohibition. — The use of alcoholic liquors as drinks and medicines is a relic of early times, when men drank because it was the custom to do so, and when physicians gave alcohol as a medicine because of its quick effect. But when the effects of alcoholic drinks were tested

and measured accurately, they were found to be overwhelmingly bad. The United States, therefore, adopted the Eighteenth Amendment to the Constitution in 1919. This amendment reads as follows:

"SECTION 1: After one year from the ratification of this article, the manufacture, sale, or transportation of intoxicating liquors within, the importation thereof into, or the exportation thereof from the United States and all territory subject to the jurisdiction thereof, for beverage purposes, is hereby prohibited.

"SECTION 2: The Congress and the several States shall have concurrent power to enforce this article by appropriate legislation."

The Eighteenth Amendment is now a part of the Constitution of the United States, and is as binding as any other part of the highest law of the land.

The Congress of the United States has defined intoxicating liquors to be those which contain one half of one per cent, or more, of alcohol by volume.

Tobacco. — Tobacco is a plant which grows about as tall as a man. It has a central stalk which bears large, broad leaves. The leaves are gathered and dried, and then manufactured into smoking tobacco, chewing tobacco, and snuff.

Nicotine. — Tobacco contains a substance called *nicotine* (nĭk′o-tĭn), which is a narcotic and a powerful poison. Two or three drops of pure nicotine would make a man dangerously sick. The quantity of tobacco which is usually taken at once contains enough

nicotine to kill a man, if all of it should be swallowed at one time. The reason why those who use tobacco are not killed by it is that they do not swallow much of the nicotine.

Effects of Tobacco. — Tobacco produces a quick form of poisoning, and a slow form. The quick form

TOBACCO PLANTS

1,500,000 acres in the United States are used for raising tobacco.

of poisoning is a feeling of stomach sickness, with paleness and weakness. Most persons are made sick when they first try to smoke or chew. The body may become somewhat used to the poisonous effects of tobacco, but even the greatest smokers and chewers become sick when they take a little more than usual at one time.

When tobacco is used day after day, it produces a slow poisoning of the heart, lungs, muscles, eyes, and other parts of the body. These effects will be mentioned when the separate organs are studied.

Tobacco and Young Persons. — Tobacco has a far greater poisonous effect on young persons than on those who are grown. Many boys think that while they are smoking they look like grown-up persons; but smoking prevents them from growing up strong and healthy. After a person has got his growth, he can stand an amount of poisoning which would make a young person dangerously sick.

Cigarettes. — Many young persons suppose that cigarettes are only slightly poisonous. A cigarette is not so poisonous as a large cigar, or a pipeful of tobacco, because it is smaller. But the small quantity of nicotine that is in a cigarette is more poisonous to a boy than the large amount of nicotine in a cigar or pipe is to a grown man. The use of cigarettes by boys is so dangerous that many states have laws forbidding their sale to those who are under eighteen years of age.

Opium. — The dried juice of poppy plants is a gummy substance called *o'pium.* It contains *morphine* (môr'fĭn) and other poisonous substances. Opium is a valuable drug which is used in medicine to ease pain and to produce sleep. It is a strong narcotic poison, and its use is so dangerous that only skilled physicians know how to give it safely. Yet many persons who begin to take it for pain form a habit of its

use, just as men form a habit of using alcohol or tobacco. The opium habit is extremely dangerous, and those who form it seldom live more than a few years.

Many lives are lost each year because the sick take opium or morphine, and then suppose that they are out of danger because they feel no pain. A pain is a valuable sign of sickness and danger. If you have a bad pain and it is taken away by the use of opium or morphine, you need a good nurse or doctor to look after you, for the narcotic dulls your mind and feelings, and you cannot judge for yourself how ill you are.

Headache Cures. — Many medicines which are sold for the cure of headache contain drugs which make the heart extremely weak. These drugs do not remove the cause of the headache, and their use is dangerous.

Drugs and Health. — Many persons suppose that some drugs will make them strong, that some will drive away diseases, and that others will make their complexions fair. This is not so. All drugs which have much effect on the body are poisons, and only trained doctors know how to use them. But giving drugs is only a small part of what a doctor does to cure a sick person. He tries to remove the cause of the sickness. For example, if a person is sick because he is tired from overwork, the doctor does not give him drugs, but tells him how to work and rest. In the prevention and cure of sickness a knowledge of the use of drugs is of far less value than a knowledge of hygiene and of right living.

QUESTIONS

Of what use are the appetites?

Name some false appetites.

What is *intemperance?*

Why is fermented wine harmful, while the fruit juice of which it is made is a good food?

How is vinegar made?

Name some uses of alcohol.

What is *wood alcohol?*

Why is it right to have laws regulating the sale of strong drink?

What is the Eighteenth Amendment to the Constitution of the United States?

What is a *stimulant?* a *narcotic?*

What is *nicotine?* What are its effects on the body?

What effect does tobacco have on young persons?

Why are cigarettes often more harmful than large cigars?

What is *opium?* *morphine?*

What is the danger from the use of opium in treating a pain?

What harmful effects do headache cures often have?

For the Teacher. — There is great need to teach the nature and effects of stimulants and narcotics. The deceitful sense of strength and well-being which they produce is to be contrasted with the real strength which is produced by proper food and rest. Three great facts about stimulants and narcotics are almost universally admitted:

1. The very great harm which they do.
2. The desirability of limiting their use.
3. The right of the government to control or prohibit their sale.

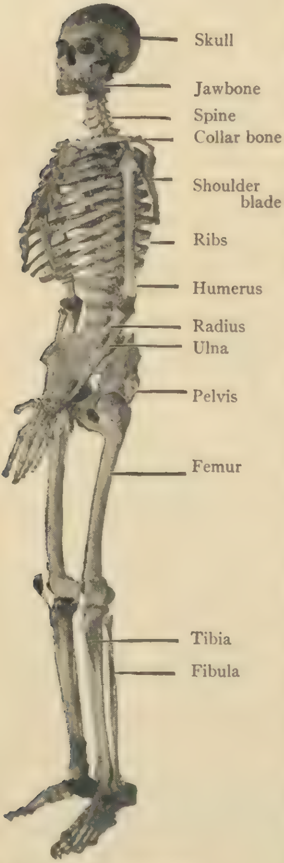
The following points are to be emphasized:

1. Appetites, their value and their abuse. False appetites, and the dangers to which they lead.
2. Alcoholic stimulants, their nature and the false sense of power which they excite.
3. What drinks are alcoholic stimulants?
4. The Eighteenth Amendment, and the laws for its enforcement.
5. The duty of citizens to enforce the prohibition laws. Personal independence. Rights and privileges of individuals are to be laid aside for the benefit of the rest of the people.
6. The danger of tobacco to young and growing persons.

CHAPTER VII

BONES AND JOINTS

The Skeleton. — The flesh is supported by a bony framework called the *skeleton.* The bones weigh about one seventh as much as the whole body. They give firmness, stiffness, and shape to the body. The size of the skeleton fixes the size of the body. If the bones are long and large, the body will be tall and large, but if they are small and short, the body will be small in size.



A HUMAN SKELETON

A bone is shaped somewhat like the part of the body in which it lies. Most of the bones of the arms, legs, hands, and feet are long and straight, like rods, and most of the bones of the head are flat and thin, like sheets of cardboard. The picture of a skeleton looks something like the picture of a very thin man, for the shape of every part of the body is outlined in bone.

Names of Bones. — There are about two hundred separate bones in the body, and each one has a name. The long bone which reaches from the shoulder to the elbow is called the *hu'merus*. Two long bones extend from the elbow to the wrist, namely, the *ra'dius* on the thumb side of the arm, and the *ul'na* on the little finger side.

ELBOW OF A THREE-YEAR-OLD CHILD

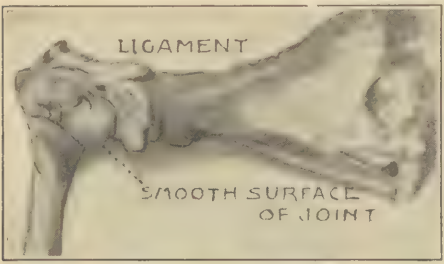
ELBOW OF A GROWN MAN

(X-ray photographs.) In the child's elbow the ends of the bones are still soft, and contain so little lime that they do not show in the picture. In the man's elbow all parts of the bone are hard and full of lime.

Joints. — Bones are joined together in such a way that most of them may turn at the joints. The elbow joint is formed by the rounded end of the humerus fitting into a rounded notch in the ulna. The arm can bend at the elbow back and forth in only one direction, for the socket of the bones is long, and is rounded in only one direction, like a door hinge. The joint at the shoulder is shaped like half a ball, and allows the arm to turn in every direction.

The backbone is made up of twenty-six bones which are piled one upon another like a long string of spools.

They are joined together by tough pads of flesh in such a way that the whole string of bones may bend somewhat, although the motion is slight between any two bones.



LIGAMENTS OF THE SHOULDER JOINT OF A SHEEP

The joint is cut open to show the smooth, rounded upper end of the leg bone.

The edges of the bones of the skull are very irregular, and are fitted together like a dove-tailed joint in a box. These bones have only a very slight motion at their joints. The only bone of the head which can move freely is the lower jaw.

Ligaments. — Bones are joined together at the joints by strong connective tissue bands called *lig′aments.* What we call *gristle* on a soup bone is composed mostly of ligaments. Many of the tendons of muscles are also fastened to the bones at the joints, and act as ligaments to hold the bones in place.

TENDONS FASTENED TO THE LIGAMENTS OF THE SHOULDER JOINT OF A SHEEP

The tendons help to hold the bones in place.

The ligaments of a shoulder, or elbow, or other joint which may be freely moved,

surround the bones like a collar, thus forming a pocket within which the ends of the bones turn. Each pocket contains a liquid, called the *syno'vial fluid*, which makes the ends of the bones smooth and slippery, like an oiled hinge.

The bones of the wrist are small and rounded, like pebbles. Ligaments of connective tissue bind them together so firmly that they seem like a single bone. Yet the ligaments will stretch slightly when the wrist is struck or strained, and the wrist will not be broken so easily as it would if composed of a single bone.

Sprained Joints. — When a joint is turned too far, or in the wrong direction, the ligaments are stretched and torn. The joint then becomes sore and swollen, and the skin around it may become blue from the bleeding of the torn ligaments.

We may help a person who has a sprained joint by soaking the joint in hot water for an hour or two. Then a bandage wound snugly around the joint will help to prevent the pain and swelling from returning. After a rest of two or three days a sprained joint will be helped by moving it, even if the motion causes some pain. If the joint is not moved early, the torn ligaments may grow together too short, or may grow fast to the bone, and the joint will then be stiff and painful for a long time.

Dislocated Bones. — When the ends of the bones in a joint slip past each other, we say that the bones are

out of joint, or *dis'located.* Putting a bone out of joint tears some of the ligaments of the joint.

Boys sometimes put their fingers out of joint in playing baseball. If a finger is out of joint, you can put it back in place by pulling upon it.

If a large joint, such as an elbow, is dislocated, bind the limb to the body, or to a narrow board, so as to keep the injured parts at rest. You can then move the person home without danger. A physician should be called to put the limb in place.

Structure of Bones. — The shafts of long bones, such as those in the arms and legs, are hollow, like the frame of a bicycle. Their ends are like a fine honeycomb, or a sponge, covered with a shell of hard bone. This arrangement makes them light and yet strong. A long bone is about twice as strong as an oak stick of the same size.

A LONG BONE SAWED IN TWO LENGTHWISE

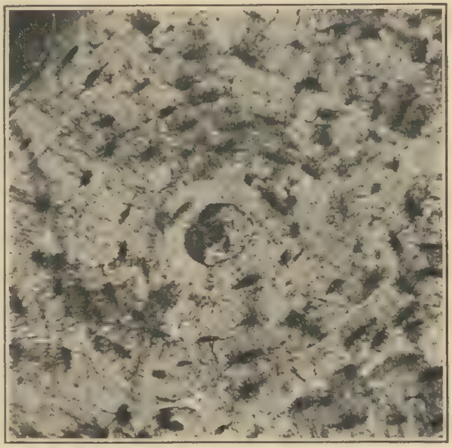
Its middle part is hollow, and its ends are spongy.

A flat bone, like one from the head, is composed of two sheets of hard bone, separated by a network of spongy bone. By this means the parts inside of the head are protected much better than if the bone were a single sheet.

A dried bone is two thirds lime and nearly one third connective tissue. Soaking a bone in a mixture of one

part of hydrochloric acid in ten parts of water will remove the lime, leaving the bone so soft that it may be tied in a knot. Burning a bone will remove the connective tissue and leave the lime.

Bone Cells. — The living part of bone is composed of cells of connective tissue, arranged in circles around the blood tubes. The cells have small bodies, and a great number of fine branches. Their special work is to take lime from the blood, and to fix it among their branches in order to make the bone hard and stiff. Every cell of the body takes a small quantity of lime from the blood for its own use, but bone cells take a great deal of lime, and use it for the benefit of the whole body.



BONE CELLS

(Magnified 200 times.) The circle in the center is a blood tube. The cells are the living parts of bone and are arranged in circles around the blood tubes.

Cartilage. — A thin, tough pad of gristle, called *car′tilage*, covers the end of each bone in a movable joint. A layer of cartilage also joins the bones together in immovable joints. Cartilage is like bone which contains only a little lime. Each bone of a

very young child consists largely of cartilage which takes up lime and becomes true bone as the child grows.

Hand of an Eight-Year-Old Child
The wrist bones are only half formed.

Hand of a Thirteen-Year-Old Child

(X-ray photographs.) The ends of the long bones are separated from the shafts by soft cartilage which gradually hardens as the child grows older.

Bone Deformities. — While the bones are young and soft, they may bend slightly if pressure is put upon them. If the pressure is kept up day after day, the bones may grow crooked and deformed. The weight of the body may bend the bones of a poorly nourished baby, thus producing bowlegs. The backbone of a child may grow crooked from his sitting at a desk which does not fit his back. If a child has his nose so stopped up that he has to breathe through his mouth, the bones of the upper jaw may be compressed sidewise so much

that the upper teeth project beyond the lips. One may prevent most deformities of a child's body by paying attention to the bones while the child is growing.

Children that are fed with only bread and coffee, or other deficient food, may not take enough lime into their bodies to make their bones hard. These children often suffer with a disease called *rickets*, in which the bones are soft and easily deformed. Rickets may be prevented or cured by giving the children a variety of nourishing food, including fresh vegetables and milk, in order to supply all the substances which are needed to form good bone. Children who do not get fresh vegetables, fruit, and milk often have a disease called *scurvy*, in which the gums, teeth, and bones become sore and tender. Children who have what were formerly called "growing pains" usually have a mild form of scurvy which may be prevented or cured by proper food.

Bone Diseases. — The solid part of a bone contains blood tubes, and grows in the same way that flesh grows. Disease germs may enter a bone, and cause it to become swollen and softened. Hip-joint disease is a form of lameness caused by the germs of tuberculosis growing in and around the hip joint. Hunchback is caused by tuberculosis germs growing in some of the bones of the upper part of the backbone, and causing them to become so soft that the weight of the body flattens them.

Repair of Injured Bones. — A bone is covered with

a tough skin, called *periosteum* (pĕr-ĭ-ŏs′tė-um), which helps to form new bone when the old bone is injured or diseased. When a bone is broken, the connective tissue cells form new cells, and fill the space between the two ends with soft flesh. The new flesh then takes up lime, and in a month or two it becomes stiff bone.

How Bones Become Broken. — The usual way in which a person breaks a bone is by falling upon it in such a way that his weight comes upon it like a sudden blow. A child's body does not fall with so much force as the body of a heavy man, and so a child's bones may not be broken by a fall which would break the bones of a man.

X-Ray Photograph of a Broken Bone

The break is in one of the bones in the arm near the wrist.

The bones of a child do not contain so much lime as the bones of a grown person, and they may safely bend more than the bones of a man.

Too much lime in a bone makes it weak and brittle, like the stem of a clay pipe. Bones take up more and more lime as a person grows older, and old persons often get broken bones from falls which are too slight to harm a young man.

What to Do for a Broken Bone. — A broken bone is

painful, and the flesh near the break is usually bluish because of the bleeding of the bone. A break may be only a crack in a bone, and may appear like a bad sprain. It is often impossible to tell a break from a sprain unless an X-ray photograph of the bone is taken. It is important to know whether or not a bone is broken, for rubbing and moving the injured part will harm a broken bone, but may help a sprain.

A BROKEN ARM WITH A FIRST-AID SPLINT

A thin board or strip of pasteboard, bound along the broken bone, makes a good first-aid dressing.

If a bone is broken in two, it may be bent at the broken spot. A slight motion will cause great pain by rubbing the broken ends together.

You can help a person who has a broken bone by binding a stick or a thin board along the whole length of the limb, using handkerchiefs for bandages. After you have done this, the bones cannot move, and you can carry the injured person home without danger to the broken part.

QUESTIONS

What is the *skeleton?*
What is a *joint?*
Describe a joint like the elbow.

Describe a joint like those between the bones of the backbone.

Describe a joint like those between the skull bones.

What is a *ligament?*

What happens to ligaments when a joint is sprained?

What should you do for a sprained joint?

What should you do for a bone that is out of joint?

How can you show that a bone is composed of both flesh and mineral matter?

What is *cartilage?*

What is a common cause of deformed bones?

What is a common cause of bone diseases?

How is a broken bone repaired?

Why do the bones of a child not become broken so easily as those of a grown man?

What should you do for a person who has a broken bone?

For the Teacher. — The older lessons in physiology usually began with the subject of bones as the framework of the body, and emphasized their number, names, forms, and uses, but made little reference to health. Some interest was given to the study by adding a little comparative anatomy and tracing homologies, such as those between arms, wings, and fins.

Later lessons emphasized the bones from the standpoints of posture and the graceful carriage of the body; but these subjects are in the special fields of the physical training teacher.

The teacher of hygiene is especially interested in bones as living tissues. Bones are full of blood tubes and nerves, and may be considered as flesh which is hardened with lime. They are subject to accidents, diseases, and inflammations, just as soft flesh is. They are also subject to two nutritional diseases, rickets and scurvy. These are the topics which need to be emphasized by a teacher of hygiene. Defects of joints are closely connected with those of muscles, and are considered in the next chapter.

CHAPTER VIII

MUSCLES

Involuntary Muscles. — Nearly all movements in the body are produced by groups of cells called *muscles*. The movements are of two kinds. One kind is that which the mind cannot control, such as the flow of blood through the body, and the passage of food through the organs of digestion. The muscles which produce these movements are called *involuntary* muscles.

Involuntary muscles are almost white, or colorless. Most of them are in the form of thin sheets surrounding the blood tubes and the tubes in which food is digested. They are composed of cells which are thick in the middle and taper toward their ends. When the cells act, they make themselves thicker and shorter. In this way they lessen the size of the tube which they surround, and produce motion in anything which the tube may contain.

Voluntary Muscles. — A second kind of motion in the body is that which is under the control of the mind, such as the movements of the arms, legs, and head. The cells which produce these movements are called *voluntary* muscles. By the word muscle we usually mean a voluntary muscle.

The muscles of the body of an animal are its lean meat. The muscles of a person are like the lean meat of a lower animal, and form about half of the weight of the body. Most of them surround the bones, and lie just beneath the skin.

MUSCLES AND TENDONS ON THE FRONT SIDE OF A CAT'S LEG

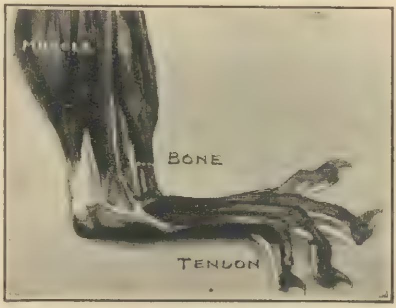
The white cords are tendons which straighten the toes.

There are about four hundred separate muscles in the body, each of which has a name. The muscle which lies on the front side of the arm above the elbow is called the *biceps* (bī'sĕps) muscle. Its use is to bend the elbow. The muscle which lies on the back side of the upper arm straightens the elbow, and is called the *tri'ceps* muscle.

Examination of a Muscle. You can see what your own muscles are like by looking at the meat in a butcher's shop, for the muscles of the common lower animals are nearly the same in number and arrangement as the muscles of your own body. A leg of lamb consists of bundles of muscles surrounding the leg bones. Each muscle is large at its middle or upper end, and tapers toward its lower end, where it ends in a strong

white cord of connective tissue called a *tendon*. The tendon is fastened to a bone in the lower part of the leg.

How a Muscle Acts. — When a muscle acts, it makes itself hard and firm, and becomes larger around and shorter than when it is at rest. In this way it draws its ends toward its middle part, and causes its tendon to pull upon whatever is fastened to it. The shortening and hardening of a muscle is called its *contraction*.



MUSCLES AND TENDONS ON THE BACK SIDE OF A CAT'S LEG

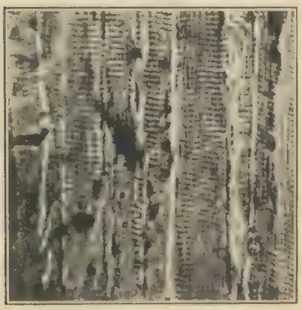
The tendons bend the toes and the claws.

Nearly all the muscles of the arms and legs are arranged like the muscles in the leg of a lamb. The upper end of each muscle is fastened to a bone, either in the trunk or in the upper part of a limb. The tendon at its lower end is fastened to another bone after crossing the joint. Each muscle usually connects two bones, and its action is to make the lower bone move at the joint like a door on its hinges. Nearly all voluntary motions of the body are the bending of joints.

You can see how a muscle acts by examining your own arm. Bend your elbow as far and as strongly as you can, and feel the biceps muscle swell in a hard bunch. Feel in the bent side of the elbow for the tendon as it pulls upon the forearm.

Face Muscles. — Many of the muscles of the face are fastened to the skin. When they contract, they move the lips and cheeks, wink the eyelids, and wrinkle the skin. The motions of the face often show how a person feels. If he is happy, his muscles will pull the corners of his mouth upward and backward in a smile. If he feels sad or is in pain, other muscles will pull the corners of his mouth downward, as in crying. If he is angry, the muscles will wrinkle his forehead in a scowl.

The face muscles which you use often will produce marks and wrinkles on the skin, and will show a great deal about your character and disposition. If you smile often, you will carry the marks of the smile through life. If you are often angry, you will carry a scowl upon your forehead. If you practice kindness and gentleness while you are young, you will carry their signs on your face all through life.



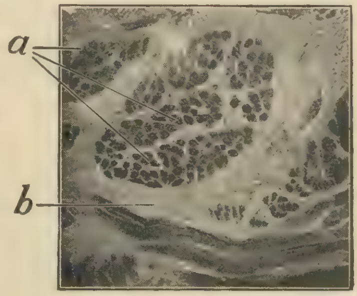
MUSCLE CELLS

(Magnified 300 times.) Muscle cells are like ribbons or strings; they have lines running across them.

Structure of Muscle. — A voluntary muscle is composed of cells about the size and shape of short fibers of cotton. If you look at muscle cells under a microscope, you can see faint lines running across them. The cells lie side by side, and are held in their places by fine branches of connective tissue cells. Muscle cells are soft like jelly, but the connective tissue

cells around them are almost as tough as fibers of cotton. The toughness of meat is due to the connective tissue in it.

The special work of muscle cells is to shorten themselves in order to produce motion in some other part of the body. There is a slight motion among the particles of every living cell, but a muscle cell can move so much that it produces motions in other parts of the body.



Muscle Cells (*a*) Cut Across

(Magnified 100 times.) The substance (*b*) between the groups of cells is connective tissue.

A tendon is composed of connective tissue fibers which are fastened to the connective tissue of the muscle.

Strength of Muscle. — A muscle one inch in diameter can lift about seventy-five pounds. Frogs and grasshoppers seem to be much stronger for their size than a man, but this is only because their bodies are lighter. A piece of their muscle is only half as strong as a bit of man's muscle of the same size.

Source of Muscular Strength. — A fine network of blood tubes surrounds each muscle cell. The blood which flows through the tubes brings both food and oxygen to the cells. When a muscle contracts, it takes some of the oxygen and oxidizes either some of the food, or some of its own substance (p. 33). The ox-

idation supplies the power and strength which the muscle puts forth in its work.

The contraction of a muscle may take place in an instant, like the uncoiling of a spring suddenly released, or the muscle may contract slowly, like a spring pulling steadily. A contraction is started by an order which the brain sends to the muscles by means of a nerve.

Muscle Growth. — Using the muscles is called *exercise.* A muscle at rest takes very little food and oxygen from the blood. If muscles are not used, they soon become small and weak, but when they work, they use up a great deal of food and oxygen, and take in a large supply from the blood. Muscle cells are living things, and when they are often called upon to do work, they prepare themselves for it by storing up a supply of food in their own substance. For this reason exercise makes the muscles grow large and strong.

Many young persons take exercise to make their bodies grow healthy, shapely, and beautiful. They go to gymnasiums to have the size of the muscles measured, and their strength tested, and to have the instructors tell them what exercises will increase their size and strength. If their upper arms are small, they take exercises which require the arms to be moved at the elbow, and in this way they increase the size of their biceps and triceps muscles. A young person can develop the muscles of any part of the body by exercising them.

Foot Exercises. — Weak ankles and flat feet are often painful in persons who stand or walk for hours. They are the result of a weakness of the muscles whose cords extend down beside the ankles and hold the foot firmly in position. A flat foot is one whose arch is turned downward. If a person walks with the toes pointing outward, the arch of the foot is turned downward at each step as the body swings forward on the foot, but if the toes are turned inward, the arch is lifted up at each step.

AN EXERCISE TO PREVENT FLAT FEET

Walking "pigeon-toed" strengthens the muscles which hold the arch of the foot upright and make the ankles firm.

Flat feet may be prevented, or cured, by walking with the toes pointed inward as far as possible for five minutes each day. This exercise will strengthen the muscles which lie on the front of the leg below the knee, and which hold the arch of the foot upright.

Crippled Children. — Muscles which are not used become soft, weak, and small. One of the principal causes of the crippling of children is muscular weakness

or disease, especially *infantile paralysis*, or *poliomyelitis* (pol-ĭ-o-mī-ĕ-lī'tĭs). This disease begins in the spinal cord and prevents a person from sending nerve messages to the muscles directing them to produce movements. The muscles then become weak and small, because the brain cannot send the orders to move them.

Muscles are arranged in opposing groups. For example, a group on the back side of the thigh bends the knee, and another on the front straightens it. If the muscles which straighten the knee are weak, the strong ones on the back of the thigh shorten themselves and hold the knee bent, because those on the front of the thigh cannot pull against them. Joints which are stiff or deformed are often made so by contractures of the muscles when the bones and joints themselves are all right. These deformities may be prevented by proper movements or exercises which prevent the stronger muscles from contracting too much. When the deformities are fully developed, they may be overcome by a simple operation.

Round Shoulders. — The principal support of the arms and shoulders are the muscles on the back side of the neck and trunk. If the muscles are weak, the shoulders fall forward, producing round or stooped shoulders. The straight back and full chest of a soldier are due to training the muscles which hold the shoulders up. You can exercise the muscles of your back by always holding your shoulders up when you sit or stand. In a little while your muscles will grow

so strong that they will support your shoulders without your thinking about their action.

Good posture and a graceful carriage of the body are produced by strong muscles. By practicing the proper posture both in sitting and in walking, you can train your muscles to hold your body in postures which are healthful and graceful.

Exercise and Endurance. — Exercise trains the muscles to work for hours at a time, and to endure hard labor without tiring. Athletes and circus actors have to take exercise every day in order that their muscles may endure their work. If they should stop exercising for a few days, their muscles would become tired soon after they begin to do their acts.

Every person has to make some use of his muscles. Even writing at a desk requires muscular work to hold the body upright, and is extremely tiresome to those whose muscles are weak. Many boys and girls at school fail in their work because they do not cultivate enough muscular strength to enable them to sit at their desks all day. Riding in an automobile or in a railroad train requires an amount of muscular work which often tires a strong man. You cannot have strength and endurance to carry on your daily work unless you take exercise every day.

Exercise and Health. — One of the greatest of all reasons for taking exercise is to keep the whole body in good order. Muscles use up the greater part of the food and oxygen which enter the body. When you

do not use your muscles, you have very little need of food. You do not have much appetite, and your stomach digests only a little food. You also have very little use for oxygen, and you breathe lightly. All the actions in your body are lessened, and you feel dull and weak all over. You must take exercise if you would keep your body well and strong.

The steps by which exercise benefits your body are as follows:

1. Your muscles use much oxygen in the process of oxidation.

2. You breathe deeply and often, and become long-winded.

3. Your heart pumps blood rapidly in order to supply the muscles with an increased amount of food and oxygen, and to remove their waste matter.

4. You feel pleasantly tired and can rest and sleep well.

5. You have a good appetite and can digest your food well.

6. Your muscles gain strength and endurance.

7. Every part of your body is strengthened by the exercise of your muscles.

Fatigue. — When excessive exercise is taken, great amounts of waste products are formed and are poisonous to the whole body. Fatigue is due as much to a poisoning by waste matters as it is to an exhaustion of the available food of the muscles. While a slight degree of fatigue is natural and leads to rest and sleep, yet a

greater degree of fatigue is harmful, especially to young persons.

Rest and Relaxation. — If muscles are to be healthy and strong, they must spend more time in rest than in contracting. When muscles are at rest, they are soft and relaxed, the joints are loose, and the limbs hang limp. You cannot rest well unless your muscles are completely relaxed while you sit or lie down. Some persons have difficulty in relaxing their muscles. Practice sitting in a chair in such a way that your whole body is relaxed and your arms, legs, and head hang limp like a piece of cloth.

Kind of Exercise. — While you sit at a desk all day, you use your muscles in a gentle way which finally tires them, but the work which they do does not require you to breathe deeply, or your heart to beat hard. The kind of exercise which helps you most is that which makes you breathe deeply, sends the blood to your face, and warms your whole body. Every man, woman, and child needs at least an hour of this kind of exercise every day. Children at school cannot have clear minds unless they take this exercise.

If you have to work with your hands, you will get exercise while you work. Farmers, carpenters, errand boys, and housemaids all get exercise while they do their work. But students and bookkeepers often have very little muscular work to do, and they may get exercise by walking, bicycling, rowing, fishing, playing outdoor games, and taking part in athletic sports.

One of the best ways of taking exercise is to become interested in some kind of active work or sport. Fads and sports, such as photography, gardening, and fishing, have often been the means of leading sickly persons to take needed exercise, restoring them to health.

Muscles need pure, fresh air as much as they need good food. The best exercise is that which is taken out of doors where the air is pure and free from dust.

Mental Effects of Games. — Playing athletic games develops those qualities which are useful in after life in earning a living, and in performing the duties of citizenship. Among the excellent qualities which games develop are the following:

Respect for rules and laws.

Obedience to leadership.

Fair play, honesty, loyalty, and chivalry.

Respect for the rights of others.

Team work and coöperation.

A sense of responsibility.

Endurance, fortitude, persistence, and self-control.

Attention and alertness.

Skill and grace in movements of the body.

Gymnasiums and Playgrounds. — Children in large cities often have no work to do, and nowhere to play. It is the duty of those who have them in charge to provide the means and the places for their exercise. It is a good investment for taxpayers to give their money for gymnasiums, playgrounds, and parks, where children can play and develop strong, healthy bodies.

Alcohol and Muscular Strength. — Many experiments have been made to find out whether or not the use of an alcoholic drink will increase a person's strength. These experiments have always proved that alcohol lessens the strength instead of increasing it. Athletes in training are not allowed to drink any form of alcoholic liquor at all.

Alcohol and Endurance. — Experiments have been made to find out whether or not alcohol will help a person to put his muscles to hard use for hours at a time. They prove that alcohol lessens the endurance. No civilized nation now supplies alcoholic drinks to its soldiers and sailors as was formerly done, for on long marches and in severe hardships those who drink are the first to fail in strength. No explorer in deserts and arctic lands will allow his men to use strong drink.

Alcohol and Accuracy of Motion. — Experiments have been made to find out whether or not alcoholic drinks will help a person to do quick and accurate work with his muscles, such as setting type or shooting at a mark. It is proved that alcohol always lessens the speed and accuracy of the worker. But very often it deceives a person and makes him believe that he is doing his work more quickly and accurately.

Tobacco and Muscles. — The nicotine of tobacco is a poison to the muscles. Tobacco cannot increase the strength. Soldiers, sailors, and explorers sometimes say that tobacco helps them to do their work. They do not use tobacco to increase their strength, but to help

themselves to be contented and to rest after doing hard work. If tobacco were of any value in helping tired persons to rest, it would be used in sickness. But those who smoke or chew do not care to do so when they are sick, for they then feel the poisonous effects of the nicotine just as if they had never used tobacco.

Tobacco is more poisonous to the muscles of a young man than to those of a grown person. A boy who smokes cigarettes cannot become a good athlete, nor endure hard work. The use of cigarettes will spoil a boy's reputation as a worker, and those who wish to employ bright, active boys will not take cigarette smokers if they can help it.

QUESTIONS

What is the difference between an involuntary muscle and a voluntary one?

Where may involuntary muscles be found?

How much of the body is composed of voluntary muscles?

How many muscles are in the body?

Where is the biceps muscle? the triceps?

What is a tendon?

What change takes place in the shape of a muscle when it starts to act?

To what are the muscles of the arms and legs fastened?

When a muscle acts, what does it do to a bone or joint?

How do the muscles of the face produce a smile?

What is the shape of a muscle cell?

What is the use of connective tissue between the cells?

How many pounds can be lifted by a muscle one inch in diameter?

From what does a muscle get its power to act?

What makes you feel warm when you work hard with your muscles?

What causes muscles to act?

What is exercise?

What are some of the benefits which you may get from taking exercise?

If your arms are small, how may you increase their size?

If you become tired out after walking a few blocks, how can you increase the endurance of your muscles?

What are the causes of fatigue?

What are some of the mental effects of playing games?

What is *infantile paralysis* or *poliomyelitis?*

How may diseased muscles cause stiffness and deformity of joints?

What is the cause of weak ankles and flat feet? How may these defects be prevented or cured?

How does exercising your muscles help your lungs?

Name some good kinds of exercise.

Give a reason why the people of a city should vote money to pay for gymnasiums and playgrounds.

What effect does alcohol have upon muscular strength? upon endurance? upon accuracy of movements?

What effect does tobacco have upon the muscles?

For the Teacher. — The subject of muscular exercise is of very great importance in keeping the body healthy and vigorous, and more attention is often given to it than to any other topic in hygiene. The physical training teacher is first of all a muscle trainer. About half of all health articles in magazines are devoted to the subject of exercise. A teacher of hygiene needs to teach only the general principles of the hygiene of muscles in the classroom.

One topic to be emphasized is the relation between muscles and crippled joints. While joints may be crippled by tuberculosis or other diseases, yet the most common form of crippling is that caused by infantile paralysis or poliomyelitis, which is primarily a disease of the spinal cord and secondarily of the muscles. Muscular unbalance and contractions of the stronger muscles are common causes of stiff joints and deformed feet. The great number of crippled children makes it desirable to teach this topic at some length. Emphasize the fact that most crippled conditions of children may be prevented or cured if the directions of skilled physicians are followed patiently for months.

Another important topic is that of weak ankles and flat feet. About twenty per cent of all children have these physical defects, and yet these may be easily remedied by proper exercises, especially by walking "pigeon-toed."

CHAPTER IX

CIRCULATION OF BLOOD

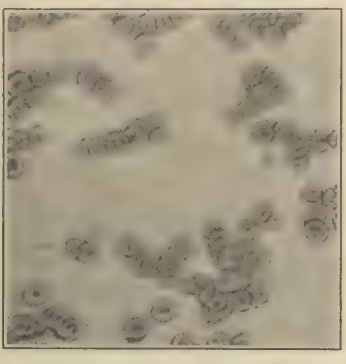
Use of Blood. — The cells of the body eat, breathe, and grow like separate microscopic animals outside of the body. They cannot go in search of food and oxygen, but everything which they need is brought to them by a red liquid that is always flowing through every part of the body. This liquid is the blood. The blood also takes away the waste matters which the cells give off, and it protects the cells from disease germs which may enter the flesh. The life of the body depends upon the blood.

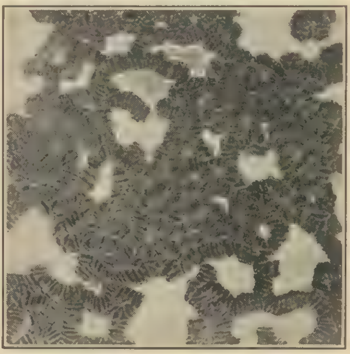
Composition of Blood. — Blood consists of a clear, yellow liquid called *plasma* (plăz′mȧ), or *se′rum*, which is full of cells called blood cells, or *cor′puscles*. About one half of the blood is plasma, and the other half is blood cells which float in the plasma.

Plasma. — The plasma of the blood consists of water containing protein, fat, sugar, and minerals, all of which are to become food for the cells of the body. It also contains small quantities of waste matters which it has washed away from the cells.

Clot. — After blood flows from the body, it becomes solid, like jelly. Blood in a solid form is called a *clot*. The effect of clotting is to form a solid mass which will stop the bleeding in a cut or wound.

Red Blood Cells. — Most of the cells which float in the blood are red, and give the red color to the blood.





RED BLOOD CELLS

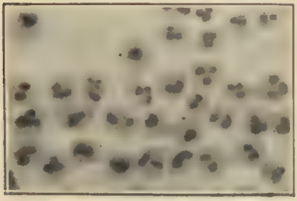
(Magnified 500 times.) Under a microscope, these cells are usually seen as at the right, piled one upon another like coins. At the left they are shown partly separated. They are light orange in color, but when millions of them are together, they appear red.

One may easily see them by examining a thin smear of blood with a microscope. A red blood cell is shaped like a thick round plate with a hollow on each side.

The use of the red blood cells is to carry oxygen from the lungs through the body. They do this by means of their red coloring matter, called *hæmoglo'bin*, which contains iron.

White Blood Cells. — Some of the blood cells are round like balls, and are almost colorless, but when many

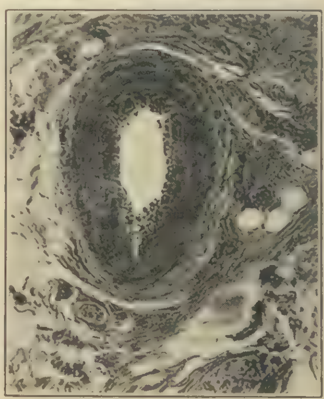
of them are seen together they appear white. These are called *white blood cells*, or *white corpuscles*. One of their uses is to destroy bacteria and other disease germs which have entered the body. We can see white blood cells by looking at the white matter from a pimple with a microscope. This matter consists of white blood cells killed by bacteria in the pimple.



WHITE BLOOD CELLS

(Magnified 500 times.) The white matter from a pimple consists of white blood cells which have been killed while fighting disease germs.

Arteries. — The blood in the body is held in tubes, and is kept in motion by a pump called the *heart*. The heart sends blood to every part of the body by means of a set of tubes called *ar'teries*. All the arteries, except those leading into the lungs, are branches of a single artery which begins at the heart and is called the *aor'ta*. The larger arteries lie deep in the flesh where they cannot be easily harmed.



A SMALL ARTERY CUT ACROSS

(Magnified 200 times.) The greater part of the wall of the artery consists of involuntary muscle.

The larger arteries in the body have been given names. For example, the one on the thumb side of the front of the wrist is called the *radial* artery.

Muscles of the Arteries. — The walls of the arteries consist largely of muscles which can contract or relax, and make the tubes small or large, according to the needs of the various parts of the body (p. 79). When a person is too warm from running, his face is red, because the arteries become large in order to allow a large amount of blood to flow near the surface of the body and become cooled.

The contraction of arteries may be seen in an earthworm. A large blood tube runs along its back and another along its under side. By watching a tube closely you can see it contract regularly about once every four seconds. The earthworm has no heart, but the regular contractions of the blood tubes keep the blood in motion.

Veins. — The blood is returned to the heart by means of a set of tubes called *veins*. The veins are like the arteries, except that in them the blood flows from the small branches into the large trunks. These large trunks open into the heart. We can see veins on the back of the hand by holding the hand down at arm's length for a moment. The blood will fill the veins, and will make them look like bluish ridges under the skin. The larger veins in the body have been given names. For example, the principal vein on the side of the neck is called the *ju′gular* (jo͞o′gû-lȧr) vein.

Valves of the Veins. — Veins contain valves which open toward the heart. When a muscle contracts, it squeezes blood from its veins. The blood must flow onward, for the valves prevent it from flowing back-

ward. Thus exercise helps the flow of blood through the body.

Proof of the Flow of Blood. — The movements of the blood were not known until an English physician, named William Harvey, discovered them and described them in a book printed in 1628.

Vein full

Vein empty between a valve and the thumb

Experiment to Show the Action of Valves in the Veins

Close the vein with the thumb over the knuckle. Squeeze out the blood by running a finger up the vein. Lift the finger and blood flows backward only to a valve. Lift the thumb and blood fills the whole vein.

You can easily perform one of his experiments to prove how the blood flows.

Press a thumb upon a vein on the back of the hand, and rub a finger from it toward the heart in order to empty the vein of blood. Lift the finger and blood will return and fill the upper part of the vein down

to a set of valves, but the lower part of the vein will remain empty. Now lift the thumb, and blood at once fills the whole vein. This experiment shows the direction of the flow of blood in the veins of the hand.

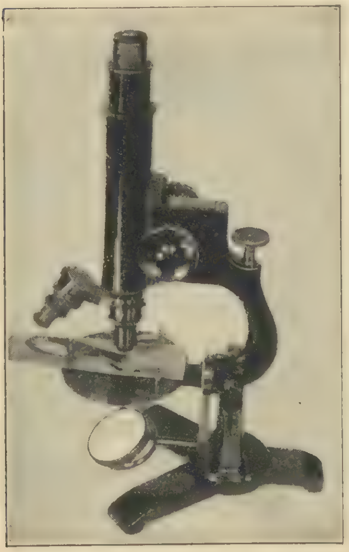
Capillaries. — Blood goes from the smallest branches of the arteries into the smallest branches of the veins by passing through a set of fine tubes called *cap'il-laries*. The capillaries extend around and between the cells of the body in a network so fine that every cell lies close to one or more of the tubes. Capillaries are so small that the separate ones cannot be seen without a microscope. They are so numerous and so close together that they make the skin look as if it were painted pink. Pressing a finger on the skin will force the blood from the capillaries, and when the finger is lifted it will leave a white spot for a moment until the blood fills the capillaries again.

CAPILLARIES AROUND MUSCLE CELLS

(Magnified 200 times.) The larger black lines are the smaller arteries.

The walls of the capillaries are so thin that some of

the plasma and oxygen from the blood easily soak through them and stay behind for the use of the cells, while the rest of the blood passes into the veins. At the same time, carbonic acid and other waste matters from the cells pass into the blood stream and flow away through the veins. Thus the capillaries distribute food and oxygen to the cells and take away their waste matters.

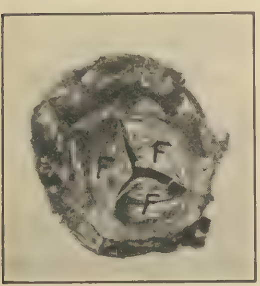


Microscope Arranged to Show Capillaries in the Tail of a Small Fish

Seeing Capillaries. — You may see the flow of blood through the capillaries by using a microscope and examining the tail of a very small fish, or the web of a frog's foot. The blood cells in a capillary appear like orange-colored balls tumbling over and over as the blood carries them along.

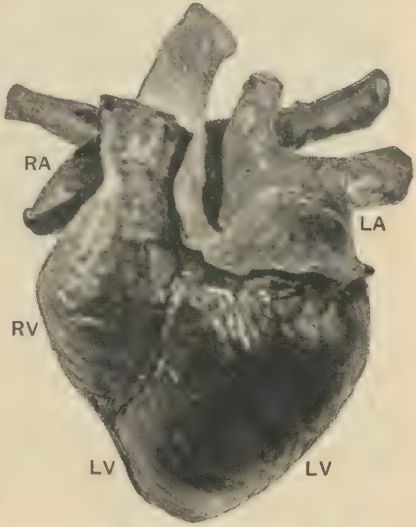
The Heart. — The heart is made of firm muscle, and is about the size and shape of a person's fist. Its smaller end may be felt throbbing under the skin a little to the left of the lower end of the breastbone. It is hollow, and is divided into four compartments, two called *au'ricles*, and two, *ven'tricles*. Each auricle receives blood from the veins, and each ventricle sends it into an artery.

How the Heart Pumps Blood. — The ventricles have thick walls of muscle which form the greater part of the heart. Each ventricle has a door, or *valve*, opening inward from the auricle, and another valve opening outward at the beginning of the artery. A ventricle re-



THE VALVE AT THE BEGINNING OF THE AORTA

It consists of three cup-shaped parts (marked *FFF*) which close at the end of a heart beat.



HEART OF A THREE-MONTHS-OLD LAMB

(Natural size.) *RA*, right auricle; *RV*, right ventricle; *LA*, left auricle; *LV*, left ventricle.

ceives blood from its auricle, and when it is full it suddenly contracts and becomes smaller, thus forcing the blood out. The valve at the auricle does not allow the blood to flow backward into the auricle, but the valve which opens outward allows it to flow into the artery.

After the ventricle has emptied itself, its muscles relax and allow more blood to enter from the auricle, but the valve at the artery closes and does not allow the blood

to flow backward from the artery. In this manner the ventricles keep the blood flowing through the arteries away from the heart.

LEFT AURICLE AND VENTRICLE CUT OPEN

The valve between the auricle and the ventricle is marked *VVV*. It is thin and white like a piece of silk. Strong, white threads hold its edges firm when it is closed, as shown above.

Pulse. — The heart of a grown person contracts or beats about 75 times each minute, and each beat sends about four tablespoonfuls of blood into the arteries. The blood flows through the arteries in spurts or waves called the *pulse beats*. You can feel the pulse when you press lightly upon the flesh over a large artery. By feeling the pulse you can tell how fast and how strongly the heart is beating. One of the best places to feel the pulse is in the radial artery on the front of the wrist (p. 96).

Circulation of Blood. — The flow of blood through the body is called the *circulation*.

A drop of blood will go the full rounds of the circulation in one or two minutes. In doing so (starting from

the left ventricle) it will pass through the following structures:

1. Left ventricle
2. Arteries of the body
3. Capillaries
4. Veins from the body
5. Right auricle
6. Right ventricle
7. Artery to the lungs
8. Capillaries of the lungs
9. Veins from the lungs
10. Left auricle
11. Left ventricle again

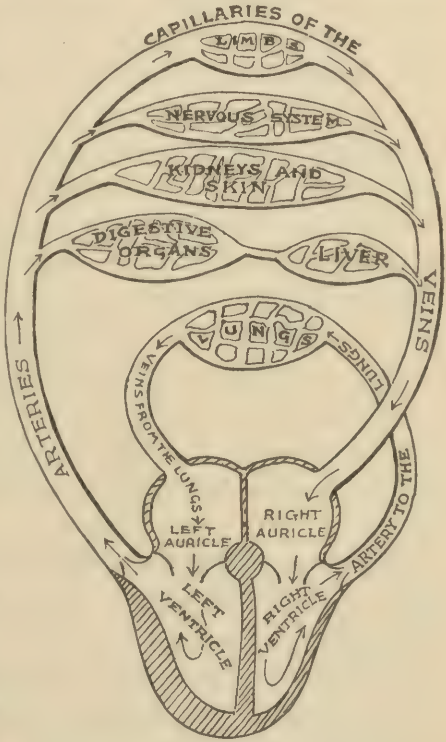


DIAGRAM OF THE CIRCULATION
The arrows indicate the direction of the flow of blood.

Lymph. — The plasma that passes through the sides of the capillaries and goes to the cells is called *lymph*. It surrounds the cells of the body and fills all spaces among the tissues, like water in a sponge. The cells of the flesh lie in the lymph like fishes in water. They take their food and oxygen from the lymph and give off their waste matters to it. The

liquid which stands on the raw flesh after a bit of skin has been knocked from the knuckles is lymph.

The Flow of Lymph. — The lymph in the flesh is slowly returned to the blood in the veins near the heart by a set of tubes called *lymphat'ics.* These tubes are so small and thin that they can scarcely be seen. They are arranged like the veins, and contain valves which allow the lymph to flow only toward the veins. When the muscles contract, they press upon the lymphatics and force the lymph out of the flesh and into the veins. Thus muscular exercise helps the flow of the liquid which nourishes and cleanses the cells.

Rubbing the limbs toward the body is refreshing to a tired person, for it makes the lymph flow back to the veins, and thus removes the waste matters from the tissues.

Circulation Compared with the Water Supply of a City. — The circulation of blood in the body is like the water supply of a city.

The heart is like the pumping station.

The arteries are like the pipes which lead from the pumping station, and send branches to the faucets in the houses.

The flow of blood in the capillaries is like the flow of water from the faucets. The use of the arteries is to carry blood to the capillaries, just as the use of the water pipes is to carry water to the faucets.

The veins are like the waste pipes and sewers which carry the waste water from the houses. A difference

between them is that the veins return the blood to the heart to be pumped over again, while the sewers empty the waste water at a distance from the pumping station.

Lymph is like water which has been drawn from a faucet, and is taken away to be used in cooking or washing. After lymph has been used, it is returned to the veins, just as the water which has been taken away from the faucets is finally poured into the sewers.

Bleeding. — The greatest danger to the circulation is that of bleeding from wounds. This subject will be discussed in the next chapter.

Regulation of the Flow of Blood. — An organ at work must use far more blood than while it is at rest. If an organ cannot get a large amount of blood, it cannot work well; and if an increased amount of blood continues to flow through it after its work is done, the organ cannot rest. A disturbance of the circulation produces bad effects almost at once. If, for example, too little blood goes to the brain, a person is faint; but too much blood in the brain produces headache and excitement.

Disturbances of the circulation occur in three principal ways:

1. In the heartbeats.
2. In the pressure of the blood in the arteries.
3. In the size of the arteries.

Heart Disease. — A person whose heart is weak or diseased cannot run or do hard work with his muscles, for the muscles cannot get the amount of oxygen which they need. The most common sign of heart weakness

is a shortness of breath which is the result of the failure of the blood to carry a full amount of oxygen through the body.

A person may think he has heart disease when he feels his heart beating hard, or his pulse throbbing in his head. These feelings are seldom caused by heart trouble, but they are due to overeating or other disturbance of the stomach, and they usually pass off when the stomach acts properly.

The most common form of heart disease is leaking valves. When a valve leaks, the heart pumps hard in order to keep up the flow of blood. It often grows in size because of the increased exercise of its muscles. A damaged heart can repair itself better than almost any other organ in the body. A person with a leaking heart valve can usually live a healthy life, if he does not overwork his heart by hard exercise.

Two common causes of heart disease are disease germs and too hard exercise.

The Heart and Disease Germs. — When a person has diphtheria, or scarlet fever, or other infectious disease, the germs of the disease may poison the whole body, especially the heart. A great danger in any infectious disease is that the heart may remain weak after the sickness has passed off.

The relation of diseased tonsils and teeth to heart disease will be described in Chapter XXV.

The Heart and Exercise. — The heart regulates its beats according to the work which the body does.

When a person takes exercise, the heart beats strongly and rapidly in order to send a large amount of blood through the muscles. Exercise will strengthen the heart, as it will any other muscle in the body. But too hard exercise may overwork the heart and weaken it. Running long races until one can scarcely stand is an example of the kind of exercise which is harmful.

The ability of the heart to endure exercise may be tested in the following way:

1. Count the pulse after the person tested has been seated quietly for fifteen minutes. It will usually beat between 70 and 80 times a minute.

2. Have the person run up and down a flight of stairs, or around the schoolhouse.

3. Count the pulse a second time as soon as the person is seated. It will now beat over 100 times a minute.

4. Count the pulse again every two minutes while the person remains seated quietly. If the heart is strong and healthy, the pulse count will drop to 70 or 80 within four minutes.

This method of testing the heart should be used on every person who expects to take part in a hard athletic contest.

Blood Pressure. — The heart forces blood through the arteries with enough pressure to cause a stream of blood to spurt up three or four feet when a large artery is cut. When a healthy person takes brisk exercise, the pressure of blood in the arteries increases, because the

heart beats fast and hard; but the pressure soon falls when a person rests. A blood pressure which is either too high or too low has a great effect upon health and strength. Much ill health in grown persons is caused by changes in their blood pressure. A physician tests the blood pressure by wrapping a flat rubber bag around the arm and pumping air into it, and noting the air pressure which closes the arteries and stops the pulse in the wrist.

TAKING THE BLOOD PRESSURE

The instrument shows the pressure which is needed to close the main artery of the arm.

A high blood pressure is often associated with diseases of the kidneys and the arteries.

Regulation of the Size of Arteries. — The circulation in a part is often disturbed by a failure of the arteries to regulate their size according to the amount of blood which the part needs (p. 97). The arteries of the stomach, for example, expand during digestion and contain an excess of blood, leaving too little blood to go to the brain; and so one feels dull and sleepy after a heavy meal. Excitement causes the arteries of the brain to expand and to hold an excess of blood, and

thus makes the brain too active and prevents sleep. Failure of the arteries to adapt their size to the needs of important parts of the body is a frequent cause of indefinite pains and other unpleasant feelings.

Hardened Arteries. — A healthy artery is soft and elastic, like a new rubber tube, and can scarcely be felt when it is rolled under the fingers. It stretches with every beat of the heart, and contracts between the beats, and thus prevents the pressure from becoming either too great or too little for health. A common form of disease of the arteries is their hardening with lime. Hardened arteries are like tubes of old rubber, and cannot expand or contract to regulate the flow of blood to a part. A hardened artery is often weak and is in danger of bursting when the heart beats hard. Apoplexy is caused by the bursting of a hardened artery in the brain.

Three common causes of hardened arteries are: 1, old age, 2, intemperance in eating or drinking, and 3, disease germs, especially those growing in the tonsils and teeth.

The walls of the arteries of old persons often become hardened with lime and may be felt like firm cords under the skin. Many of the effects of old age are the result of a hardening of the arteries. Infectious diseases and intemperance in eating and drinking may cause a hardening of the arteries of a young person, and cause that person to look and act like an old man. Leading a temperate life and avoiding infectious diseases are great helps in preserving the vigor of youth into old age.

QUESTIONS

What is the circulation?

Of what is blood composed?

What are red blood cells? What is their use?

What are white blood cells? What is their use?

What is plasma? What is its use?

What effect does clotting have on bleeding?

What are arteries?

Of what use are the muscles in the walls of arteries?

What are veins? Of what use are their valves?

What are capillaries?

What changes occur in the blood while it is passing through the capillaries?

Describe the heart and its contractions.

What is a ventricle? What is an auricle?

What is the pulse? Where may the pulse be felt easily?

Through what structures does a drop of blood pass in making a complete round of the circulation?

What is lymph?

What causes the lymph to flow in the flesh?

What effect does exercise have on the heart?

How may the ability of the heart to endure exercise be tested?

What is the most common sign of heart disease?

What are some common causes of heart disease?

How may the blood pressure be tested?

What are some of the effects of hardened arteries? What are some of the causes of the hardening?

For the Teacher. — This chapter on the circulation is divided into two parts: 1, the general principles of the circulation, which are to be learned accurately; and 2, the four practical applications of high blood pressure, heart disease, test for heart efficiency, and hardened arteries.

The causes of circulatory diseases often date back to conditions which may be corrected in youth and childhood. Emphasize infected teeth and tonsils as causes of circulatory diseases.

CHAPTER X

EMERGENCIES

Causes of Accidents. — Accidents are far more frequent in America than in Europe because of the extreme degree of the American feeling of personal freedom to do as one pleases. But American freedom requires every citizen to respect the rights and feelings of one's neighbors and associates. It is the duty of every person not only to guard his own body against injury, but also to watch that he does not injure others. Safety first depends largely on good manners, courtesy, and a respect for the rights of others.

There are three great causes of accidents:

1. Ignorance, such as the running of automobiles and other machinery by unskilled persons.

2. Carelessness, or a lack of a sense of responsibility.

3. Recklessness, or taking chances when the danger is well known.

One of the greatest influences in preventing accidents is an educated public sentiment which will not laugh at the ignorant, the careless, and the reckless; but will condemn them as dangerous lawbreakers.

Safety First. — Accidents are not necessary, and most of them could be prevented. *Safety first* is the great lesson which railroad officials, factory managers,

policemen, teachers, and other leaders are trying to impress upon all the people. Among the principles which are taught in safety-first campaigns are the following:

1. Care at railroad crossings and on cars.

2. Attention at street crossings.

3. Care in the use of firearms and fireworks.

4. Care in throwing stones and other missiles, and in the use of sling shots.

5. Care in handling knives, scissors, and other sharp instruments.

6. Carefulness in driving automobiles.

7. Refraining from tricks and practical jokes.

8. Heeding safety signs.

Fire Prevention. — One of the greatest dangers to property, health, and life is that from fire. It is far easier to prevent a fire from starting than to put one out. Among the points to which attention should be given are the following:

1. Care in the use of matches and in extinguishing them before throwing them away.

2. Care in disposing of lighted cigarettes and cigars.

3. Care in starting bonfires and in watching them until they are entirely out.

4. Care in the use of gasolene, benzine, turpentine, and other liquids which are explosive or inflammable.

5. The danger of cleaning clothes with explosive liquids in a room.

6. The danger of using rubber tubing instead of metal pipe in connection with gas fixtures.

7. The danger of allowing rubbish to accumulate in back yards and near buildings.

8. The necessity of knowing the location of the fire-alarm box and fire hydrant nearest your home and your school.

9. The way to give an alarm of fire.

10. The way to use a fire extinguisher.

Panic. — Accidents nearly always happen suddenly, and the danger is usually over in a very short time. If an accident happens in a crowd, one of the greatest of the dangers is that people will hurt one another in trying to get away from the place. Often those who are in an accident do not take time to think, but they push and throw each other down, and in that way they often do more harm than the accident itself. When the persons in a crowd become filled with fear and act without thinking, like a flock of frightened sheep, we say that they are in a *panic*. A sudden danger which requires quick action is called an *emergency*.

Fire Drill at School. — A cry of "Fire" in a crowded meeting place will often cause a panic. Lives have sometimes been lost in panics when a large number of people in a crowded hall have tried to escape at once from a harmless fire. Most panics are caused by too great a hurry to escape from a supposed danger. Two persons are all that can go through the usual-sized doorway at once. If half a dozen try to crowd through at one time, some one is likely to be hurt.

Fire drills at school teach boys and girls how to go out of a building quickly and safely. When an alarm bell is rung, the pupils drop their books and march out of the building in good order. In this way a large schoolhouse can be emptied in less than two minutes. This is far less time than it would take a fire to spread in a dangerous way.

Boys and girls who have been trained in fire drills are likely to be cool and thoughtful when an accident happens or danger arises in any place.

Learning to Swim. — A great many persons lose their lives because they do not know how to float in water. Many persons who can swim lose their lives in trying to save those who cannot swim, but who become frightened and pull their rescuers down with them. Nearly every daily paper in summer has news of drowning accidents that have occurred during the day. Most of the drowned persons could have been saved if they had learned to be cool when in danger, and had helped those who tried to save them. All of them would have been saved if they had taken the trouble to learn to swim while they were young.

It is your duty to learn to swim. Go to the water with a friend who knows how to swim, and make up your mind that you will not be frightened. Do as he tells you, and you will quickly learn to swim.

If a person is nearly drowned, you may be able to save his life by doing artificial respiration. The way to do this is described on pages 144–146.

Curiosity of a Crowd. — When a person is hurt, or is taken sick, those who are near by often crowd around him out of curiosity to see what is going on. This is the wrong thing to do, because it shuts off the fresh air from the injured person, and interferes with those who try to help him. When a person is hurt, do not rush to look at him, but keep away unless you are able to help. If a doctor or nurse is working over the injured person, you can do no good by looking on, but you are likely to do great harm.

First Aid. — If you are near some one who is injured, you may be of great help in giving him first-aid relief. Obey the leader if some one is directing the relief; or assume the leadership yourself if no one else does so. Observe the injured person carefully and think what to do before you try to give first aid.

There are always three things to look for and to think about in an accident to a person: first, what is called the *shock* of the accident; second, bleeding; and third, broken bones.

Shock. — A person who falls, or is struck a hard blow, or is suddenly hurt in any way, usually feels dizzy, short of breath, and sick, and often does not know anything at all for a moment. This sickness is called *shock.* If a person is suffering from the shock of an accident, do not rub him, or shake him, or force him to swallow liquids, for these things may make the shock worse. Lay the injured person down on his back so that his heart and breathing may go on as undisturbed as

possible. While he is lying still, observe him for bleeding, broken bones, and other dangerous conditions. Send for a physician, but while waiting for him, do what you can for the person.

Bleeding. — A great danger in an accident is that of bleeding from a cut or wound. A person may lose a cupful of blood without danger, but if he loses a pint, he will be weak and faint. Bleeding from a small wound usually stops within five minutes, for the blood clots, and closes the open tubes (p. 95). Bleeding from a large artery is dangerous, for the blood flows so swiftly that its stream washes away the clot as fast as it is formed. Bleeding from a vein usually stops itself, for the blood pressure in a vein is so small and the blood stream flows so slowly, that the clot remains in the tube.

Five Experiments. — Bleeding comes from an open blood tube, and will stop if the tube is held closed by a pressure which is somewhat greater than the pressure of the blood in the tube. You can understand how and where to make the pressure if you do the following experiments:

1. Learn to feel the pulse in the wrist. Grasp the right wrist of one of your companions and feel the pulse with the first two fingers of your right hand. The artery in which you feel the pulse lies on the front, thumb corner of the wrist.

2. While you are feeling the pulse with your right hand, press upon the artery with a finger of your left

hand placed an inch or two above the place where you feel the pulse. Notice that a little pressure stops the pulse, for it closes the tube of the artery. The same amount of pressure on a wound, or on the flesh around it, would stop the bleeding, even if a large artery were cut in two.

FOUR EXPERIMENTS WITH THE PULSE

A pulse shows that blood is flowing through the artery; and no pulse shows that no blood is flowing. 1, Feeling the pulse in the wrist; 2, stopping the pulse by pressure on the artery near the wrist; 3, stopping the pulse by pressure on the main artery of the arm above the elbow; 4, stopping the pulse by means of a twisted handkerchief, or tourniquet.

3. While you feel the pulse with the right hand, as before, grasp the arm of your companion above the elbow with your left hand, holding your fingers straight in order to press as far as possible around the arm. Shut the hand as tightly as you need to until you cannot feel the pulse in the wrist. Notice that you can easily close

your hand firmly enough to stop the pulse. This pressure would be sufficient to stop all bleeding even if an arm were cut off. You could hold a bleeding arm in this way for an hour or two if you had to do so.

4. Pass a handkerchief around the arm of your companion above the elbow, and tie it so loosely that you can put your fingers under it easily. Twist the handkerchief, and notice how hard you have to twist it in order that you cannot feel the pulse in the wrist. You do not have to twist it hard enough to cut into the flesh or cause pain. If the arm were cut below the elbow, it could not bleed, for no blood could flow beyond the handkerchief. A handkerchief or other band used in this way, as shown in the fourth picture on page 117, is called a *tourniquet* (tōōr′nĭ-kĕt).

5. Now untwist the handkerchief slightly until you can feel the pulse again, and hold it in that way for a moment or two. Notice that the veins become filled with blood, and that the arm swells and turns purple. The pressure on the veins keeps the blood from flowing out of the arm, but the arteries remain open and continue to bring blood into the arm. If there were a bleeding wound on the arm below the elbow, the handkerchief would increase the bleeding because the veins and capillaries would be distended with blood.

If you do these five experiments carefully, and understand their meaning, you will be able to stop any bleeding which you can reach with your hands.

How to Stop a Bleeding. — If you wound yourself, or see another person bleeding, there are five things which you can do to stop the bleeding, all of which consist in making pressure upon the cut blood tubes.

STOPPING A BLEEDING BY GRASPING THE SIDES OF THE CUT

You can stop almost any bleeding by using your fingers or hands in the way shown here.

STOPPING A BLEEDING BY PRESSING A HANDKERCHIEF UPON THE BLEEDING SPOT

You do not need to make a painful pressure in order to stop the flow of blood.

1. Grasp the flesh around the wound and press the sides of the wound together, so as to close all the blood tubes which go to the wounded place. You may need to use both hands if the wound is large; but if the wound is small, you can press directly upon the bleeding spot.

STOPPING A BLEEDING BY BINDING A HANDKERCHIEF UPON THE WOUND

Make the binding handkerchief fit snugly and evenly.

2. Take a clean handkerchief or any piece of clean cloth and hold it firmly upon the wound. You may need to hold it for five or ten minutes, or until a firm clot forms in the blood tubes.

3. Crumple a clean handkerchief into a pad and tie it upon the wound by means of one or two more handkerchiefs passed around the wounded limb.

4. Grasp a bleeding arm or leg above the wound and shut your hands around it, just as you grasped the arm in the third experiment with the pulse (p. 117). You might need to do this if the wound is large and the flesh is badly torn. You will not need to squeeze the limb with great force, but you can easily hold the blood tubes closed a long time.

5. Tie a handkerchief loosely around the limb and twist it in order to form a tourniquet as you did in the fourth experiment with the pulse (p. 118). By this means you can stop the bleeding if a hand or foot is cut off.

A danger in the use of a tourniquet is that you may twist it so hard that it cuts into the flesh and causes pain. Another danger is that you may not twist it hard enough. If the tourniquet stops the flow in the veins but not in the arteries, it may even increase the bleeding (see the fifth experiment, p. 118).

An Arm Sling. — When a wounded part has stopped bleeding, you need to keep it at rest in order to prevent disturbing the blood clot. If an arm is wounded, you can support it in a sling.

Fold a large handkerchief, or a square yard of muslin, once, making a triangle. Place the middle point of the triangle under the elbow and bring the ends up over the shoulders and tie them behind the neck.

An Arm Sling

Fold the cloth once in a triangle. Place the square angle under the elbow. Bring the ends up over the shoulders. The end lying under the arm goes over the shoulder opposite the supported arm.

Nosebleed. — Blood in a bleeding nose nearly always comes from an open vein in the front part of the nostrils.

If you have a nosebleed, you can stop it by holding your nostrils closed with your thumb and finger for about five minutes while you breathe through your mouth. This will close the vein and allow the blood to clot in it.

Dressing a Wound. — When bleeding has stopped, a wound must be dressed in order to prevent disease germs from entering it. When a person is wounded in an accident, you may have to use whatever dressing there is at hand. Clean handkerchiefs make good dressings, or pieces of cloth torn from a clean shirt or undergarment.

Three common dressings which you can buy are:

1. Gauze roller bandages, each 10 yards long. The best width is two and one half inches.

2. Sterilized gauze in packages of one yard each.

3. Absorbent cotton in rolls, or packages, of various sizes up to one pound each.

When you apply a first-aid dressing to a wound, crumple up some of the dressing so as to make a flat pad. Place the pad on the wound and bind it in place with a handkerchief or roller bandage. The pad of dressing, pressed upon the wound, will also help to keep the wound from bleeding.

BANDAGING AN ARM WITH A ROLLER BANDAGE

Lay the bandage obliquely so that both its edges are snug.

When you apply a first-aid dressing, there are three reasons why it is usually best not to wash the wound:

1. You are likely to remove the blood clot and increase the amount of bleeding.

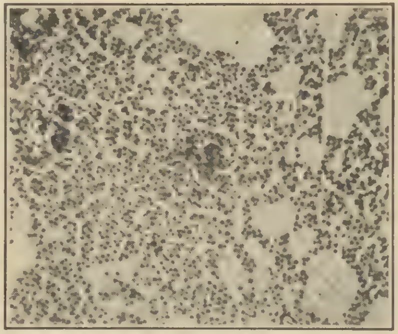
2. You are likely to put dirt and disease germs into the wound.

3. Blood itself is a good dressing for a wound.

Disease Germs in Wounds. — A wound will usually heal quickly and without pain or tenderness if no disease germs grow in it; but if disease germs are present, they keep the wound from healing and cause it to be red and sore. Redness and soreness in a wound and the skin around it are signs that disease germs are poisoning the wound.

When disease germs grow in a wound, the white blood cells attack them. But often many of the blood cells are killed by the germs. The white matter, or *pus*, which runs from sore wounds, pimples, and boils, consists of white blood cells which have died while they were defending the body against disease germs.

The disease germs which grow in wounds are the same kinds as those in pimples and boils. They are scattered almost everywhere, for pimples, boils, and small sores are common, and their germs are in most dirt of houses and streets. They may usually be found growing among the dead cells of epidermis on the surface of the skin, and are likely to enter every wound, unless great pains are taken to keep them out.



Disease Germs That Grow in Wounds

(Magnified 1000 times.) These are the kind that causes boils.

One of the principal sources of disease germs in wounds is the skin itself. The best means of killing disease germs in the skin around a wound is *iodine* (ī′o-dĭn). When you are ready to dress a wound, wipe the blood from the skin around it and paint the skin with tincture of iodine. It will do no harm if some of the iodine gets into the wound itself.

If you receive a small wound, such as a cut finger, paint it with iodine and wrap a clean dressing around it.

Wet Dressings. — If a wound is already sore and disease germs are growing in it, or if the skin around a wound is dirty, you can kill the germs by using a dressing which is kept wet with clean water. When a dry dressing is used on a sore wound, the pus which runs from it dries and forms a crust or scab which holds the pus and disease germs in the wound. A wet dressing soaks up the pus and disease germs and removes them from the wound as fast as they are formed, and so it keeps them from poisoning the flesh.

You can make a wet dressing by wetting a dressing every hour or two. Boil the water in order to kill all disease germs which may be in it. You can add a substance, such as borax, which will help to kill the disease germs.

All kinds of dressings which are sticky or greasy, such as sticking plaster, court-plaster, and salves, are usually harmful to a wound, for they keep the pus and other discharges from leaving the wound.

Emergency Dressing Outfit. — Those who are camping or traveling where they cannot reach a doctor quickly, need to carry a box of supplies for dressing wounds. The following is a good list for two or three persons to take:

One package of absorbent cotton, $\frac{1}{8}$ pound.

Four gauze bandages, each two and one half inches wide.

Three packages of gauze, one yard each, for dressings.

A glass-stoppered, half-ounce bottle of tincture of iodine.

Scissors for cutting the dressings.

These dressings will be enough for two or three wounds, and will enable you to give first aid in any wound which you are likely to see.

Tetanus. — There is a disease, called *tet'anus*, or *lock-jaw*, in which the muscles of the whole body become contracted, beginning with those of the lower jaw. The disease is caused by disease germs which often grow in the intestines of horses and cattle, and are often found in street dirt and the soil of cultivated fields. They do not grow in wounds which the air can reach, but they often grow in deep wounds which the air cannot enter, such as those made by dirty splinters and nails which carry the germs deep into the flesh. The germs may grow beneath burned flesh, as in wounds made by fire-crackers. The disease is severe and painful, and often produces death.

Tetanus may be prevented, and usually cured, by the use of tetanus *antitoxin*. A hypodermic injection is given into the skin when the wound is first dressed. Many boards of health supply the antitoxin free to be given to those who are wounded or burned deeply.

Broken Bones. — When a person has been hurt, try to find out whether or not his bones are injured. A broken bone is not dangerous to life unless it sticks through the flesh, but it is always painful. Sprains,

and bones out of joint, are also painful, but not dangerous to life.

You may lessen the pain of a sprain, or of a bone out of joint, by bandaging a stick or thin board to the limb in such a way that it keeps the injured part at rest (p. 77). Then the person may be moved with comfort and safety.

Fainting. — A person who is weak, or sick, or hurt, or frightened, sometimes looks pale, feels dizzy, and falls down and knows nothing for a few seconds. We then say that he has *fainted.* What has happened is that the heart has suddenly become weak and has failed to send blood to the head, and the mind has stopped acting for a moment.

When a person faints, lay him down and keep his head low, so that blood will flow to it. Rub his body, or throw cold water into his face, so as to rouse him. In a moment his heart will begin to beat strongly, and he will soon feel well again.

Fits and Convulsions. — Sometimes a person suddenly falls down, his arms and legs stiffen and shake, and his face twitches as if he were in pain. We then say that he has a *fit*, or *convul'sion.* The stiffness and twitching are caused by contractions of most of the the muscles of the body. While a person is in a fit, he knows nothing and does not suffer.

A fit in a grown person is usually caused by a brain trouble called *ep'ilepsy.* While a person is in a fit of epilepsy, almost the only immediate danger is that he

may bite his tongue or cheeks. You may prevent this by pressing a handkerchief into his mouth, so as to keep the tongue away from the teeth. You can do nothing to bring a person out of a fit, but in a minute or two the fit usually passes off, and the person feels well again.

A fit in a baby is usually caused by spoiled food in its digestive organs, and usually stops when the cause is removed.

Hysterics. — There is a kind of fit, called *hyster'ics*, in which a person laughs and cries, and also moves the body as in a real fit. But the person who has hysterics knows what is going on, while in a real fit he knows nothing at all. Hysterics are usually caused by fear, or worry. The person who has them acts like a spoiled child that throws itself on the floor, and kicks and cries.

There is no danger from hysterics. Keep yourself calm and cool-headed, and act toward the sick person just as you would toward a spoiled child.

QUESTIONS

Name some of the principal causes of accidents to persons.

Name some important topics in studying about *safety first.*

Name some important measures of fire protection.

What is a *panic?*

Of what use are fire drills at school?

Give some reasons why every boy and girl should learn to swim.

Why is it harmful to an injured person for a crowd to gather around him?

What is meant by *shock* due to an accident?

What should you do for shock?

Where can you feel the pulse easily?

How can you stop a bleeding wound with your bare hands?

How should you apply a dressing to a wound in order to stop its bleeding?

How should you apply a tourniquet to stop a bleeding wound?

How should you dress a wound?

How and why should you apply iodine to a wound?

Describe a wet dressing. When should it be used?

How should you stop a nosebleed?

How should you help a person who has a broken bone?

What condition of the circulation causes a person to faint?

How should you help a person who is faint?

What is a fit?

What should you do to help a person who is in a fit?

How can you tell hysterics from a real fit?

What should you do for a person who has hysterics?

For the Teacher. — An emergency is an unexpected or unfamiliar condition. Anticipate the common conditions in which panics occur, and drill the pupils in simple methods of meeting them.

Panic is best prevented by the discipline of fire drills. Children who frequently take part in fire drills are likely to be cool and thoughtful in any emergency. A special point to be emphasized is the danger of collecting in crowds out of curiosity at fires and accidents.

Emphasize the danger of doing too much for a person in a shock. Do not be misled by outcries of an injured person. One who is making a noise and tossing his body about is probably more frightened than hurt, for a badly injured person is likely to be dazed or unconscious.

Always examine an injured person for the appearance of blood. If a bleeding spot is found, grasp it at once boldly and hold it fast, so as to stop the flow of blood. Remember that a tourniquet is the last means to try in stopping a bleeding, and that it cannot be applied to many parts, such as the head, neck, and trunk.

Do not burden the pupils with distinctions between venous and arterial bleeding. The same methods will stop either kind.

Demonstrate the method of applying a first-aid dressing to a wound. Emphasize that there is danger of infecting a wound by attempts to clean it, and that blood itself, bound upon a wound, is nature's own effective cleansing agent.

Demonstrate also the method of applying a wet dressing, and its very great value in killing disease germs at their very entrance into the wound. Emphasize the value of iodine in treating small wounds.

CHAPTER XI

RESPIRATION

Respiration and Oxidation. — Several pounds of substances enter the body each day, and yet the body increases its weight only slightly, for the amount of substances which leaves it is almost equal to the amount which enters it. The substances which enter the body are food and oxygen. These substances are built into flesh and blood, and then are given off from the body in the form of carbon dioxide, water, urea, and other waste substances which are formed by the process of oxidation (p. 34). The process of taking and using oxygen by the living body is called *respiration*. A complete act of respiration is done in four steps:

1. Breathing, or taking oxygen into the body.
2. Carrying the oxygen through the body by means of the blood.
3. Oxidation.
4. Removing the oxidized substances.

The Lungs. — The first step in respiration is that of breathing, or taking oxygen into the body. The oxygen is taken from the air by means of organs, called *lungs*, which are composed of millions of tiny, thin-walled air sacs. Air enters the sacs by passing from the nose through a tube, called the *windpipe*, or

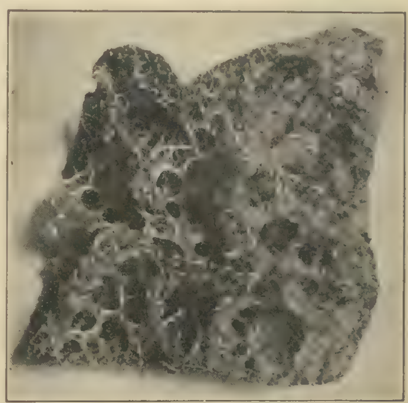
trachea (trā'kė-*ȧ*). This divides again and again into branches, called *bronchi* (brŏng'kī), the smallest of which end in the air sacs. The air sacs and branches are like bunches of hollow grapes hanging from hollow stems.

FROG'S LUNG

(Natural size.) It is a thin bag with shallow partitions.

The structure of a human lung may be illustrated by the lungs of a frog and of a turtle.

A frog's lung is a thin-walled sac, about the size of the last joint of a person's finger. Its inner surface is marked off into shallow spaces with low partitions over which arteries and capillaries run. The whole lung is like a single air sac in a human lung greatly magnified.



TURTLE'S LUNG

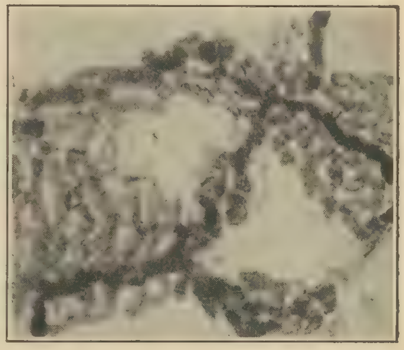
(Natural size.) It is crossed by partitions running in every direction; and is like a magnified bit of human lung.

A turtle's lung is divided into a great number of large air spaces by thin walls which extend in every

direction through the lung. Each air space is like an enlarged air sac in a human lung.

Breathing. — The lungs hang in the bony box called the *chest*, or *tho′rax*, whose sides are formed by the ribs, and the bottom, by a dome-shaped sheet of muscle, called the *diaphragm* (dī′ȧ-frăm). When the ribs are raised, or the diaphragm flattened, the chest becomes larger and sucks air into the lungs. When the chest muscles relax the chest becomes smaller, and expels air from the lungs. The passing of air into and out of the lungs is called *breathing*. Taking air into the lungs is called *inspiration*, and forcing out the air is called *expiration*. A person usually breathes fifteen or twenty times each minute.

The Red Blood Cells. — The second step of respiration is that of carrying oxygen through all the body. The inside of each air sac is covered with a close network of capillaries. As the blood flows through the capillaries, its red cells take up oxygen from the air sacs, and they then carry it through the arteries to all parts of the body. The oxygen which the red cells carry



CAPILLARIES ON THE INSIDE OF AIR SACS

(Magnified 500 times.) Capillaries are closer together here than in any other part of the body.

makes the blood in the arteries bright red in color. The red blood cells take up about one and a half pounds of oxygen from the air sacs every day.

As the red blood cells pass through the capillaries of the muscles and other organs, they give their oxygen to the living parts that need it. The blood which flows back to the heart is dark red in color because it lacks oxygen.

A fish gets its oxygen from the air which is dissolved in the water. Its *gills* are like combs whose teeth project into the water. Red blood cells, passing through the capillaries in the gills, take up oxygen from the water. A fish breathes by opening and shutting its mouth in order to keep a fresh supply of water running over its gills.

Oxidation. — The third step in respiration is the *oxidation* in the living cells. Some oxidation takes place with nearly every act which a cell does. Muscles use more oxygen than any other group of cells. When muscles do hard work, they quickly use all the oxygen which the red blood cells can bring to them. Breathing then becomes rapid and deep, and the heart beats hard and fast in order to carry more oxygen to the muscles. When the muscles have used all the oxygen that they can get, the strength fails, and a person has to stop exercising.

Carbon Dioxide. — The fourth step in respiration is that of removing the oxidized substances from the body. Anything which has been fully oxidized is

usually of no further use to the body, but is a waste substance which the body throws off. One of the principal waste substances of the body is *carbon dioxide* (p. 34).

The blood, passing through the capillaries in all parts of the body except the lungs, takes up carbon dioxide and carries it to the lungs, and there gives it off to the air in the air sacs. The carbon dioxide then passes out from the body with the breath of the next expiration.

Summary of the Changes Produced by Breathing. — During inspiration, the lungs receive oxygen. During expiration, the lungs give off carbon dioxide.

The air sacs of the lungs give oxygen to the blood, and receive carbon dioxide from it.

In the lungs the blood takes oxygen, and gives off carbon dioxide.

In the capillaries of the body the blood gives off oxygen and takes up carbon dioxide and other waste substances.

The cells of the body take oxygen from the blood, and give carbon dioxide and other oxidized substances to it.

The Objects in Respiration. — Respiration is carried on for two objects:

1. To produce the heat which warms the body.
2. To produce the power which drives all the machinery of the body.

The body needs power to carry on every movement,

thought, or other action of its machinery. This power comes from the oxidation which takes place while the action is going on. If any one of the four steps of respiration is done imperfectly in your body, you feel dull, lazy, and weak. But when oxidation takes place in a perfect manner, you feel bright and active, you enjoy your work and play, and your whole body is strong and vigorous.

Breathing and Health. — You can increase your strength and endurance, as well as your health, by doing those things which will help the oxidation in your body. There are two principal ways of doing this:

1. By taking exercise.
2. By practicing deep breathing.

Exercise and Oxidation. — Most of the oxygen which enters the body is used by the muscles. When the muscles are at rest, the body uses little oxygen; but when you take exercise, your muscles use much oxygen, and you feel short of breath and have to breathe deeply. During exercise the body uses four or five times more oxygen than while it is at rest. Exercise also starts up all the other actions of the body (p. 88).

Deep Breathing. — If you have to sit still for hours and have but little time for exercise, you can increase the oxidation in your body by taking deep breaths often. When you begin to feel dull, sit up straight, take a deep breath, and hold it while you throw your shoulders back. This will stretch the air sacs of your

lungs wide open, will fill them with a large amount of oxygen, and will make you feel bright and active.

Lung diseases may be caused by disease germs which enter the lungs with impure air. If the lungs do not receive a large quantity of air, the disease germs will lie quiet in the air sacs and the smaller air tubes, and will grow there undisturbed. But deep breathing will stir up the germs and drive them out of the lungs. The movements of breathing will cause the blood to flow freely among all the air sacs, where its white blood cells will destroy the disease germs which may enter the sacs. Deep breathing is one of the best of all means for preventing lung diseases and promoting health.

MEASURING THE EXPANSION OF THE CHEST

An expansion of less than two inches is small for a twelve-year-old boy.

Measurement of Breathing. — There are two easy ways of measuring the quantity of air which you take into your lungs. One way is by passing a tape measure around your chest under your arms and noting the size of your chest before taking a breath, and again after

taking it. An expansion of three inches is large for a twelve-year-old boy. An expansion of less than two inches is too little for him.

Another way of measuring the air which you breathe is to fill a large glass jar with water and turn it upside down in a shallow pan of water in such a way that the water remains in the jar. Then pass a rubber tube under the water into the jar, and blow through it. As air enters the jar, the water passes out. By measuring the distance the water sinks in the jar you can tell how much air you breathe out from your lungs.

Collecting the Air Blown from the Lungs, So That It Can Be Measured

As air is blown into the bottle, water leaves it.

When a man sits still at a desk and breathes quietly, he expands his chest about half an inch, and inhales about thirty cubic inches, or a pint, of air with each breath. When a strong man takes a very deep breath, he expands his chest four or five inches, and inhales from two to four quarts of air.

A single deep breath of air will last your body less than a minute. You cannot store oxygen in your body, but you must take it into your body at the moment when you need to use it.

QUESTIONS

What is respiration?

What are the four steps in a complete act of respiration?

Describe the lungs.

Describe the process of breathing.

How is oxygen carried through the body?

Describe the process of oxidation in the body.

Describe the process of getting rid of oxidized products.

What are the objects of respiration?

By what means can you promote oxidation in your body?

How does exercise promote vigor and health?

How does deep breathing promote health?

How can you measure the amount of air which you can breathe into your lungs?

How many inches should a twelve-year-old boy be able to expand his lungs?

For the Teacher. — In this chapter the subject of oxidation is discussed from the standpoint of the intake of oxygen. In the next chapter and Chapter XXII it is discussed from the standpoint of the intake of food. The processes of nutrition and oxidation are closely related, and each must be understood in order to understand the other.

Emphasize the four steps in a complete act of respiration as described in the text.

Practical hygienic applications of the subject of respiration are made in the topics of deep breathing and of exercise.

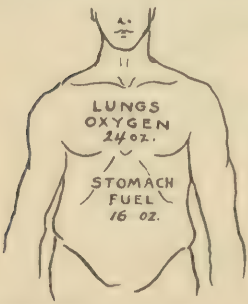
Emphasize the relation of exercise to respiration. Since most of the oxygen which enters the body is used during muscular action, exercise of the muscles is about the only practical means of increasing or controlling respiration. This explains the great value of exercise in maintaining a high degree of efficiency in the actions of the body.

Demonstrate the methods of estimating the efficiency of breathing by measuring the expansion of the chest, and the quantity of air which can be expired from the lungs.

CHAPTER XII

HINDRANCES TO BREATHING

Balance of Food and Oxygen. — Good health depends upon a proper balance between the amount of food and the quantity of oxygen which are taken into the body. The weight of oxygen which a person needs in a day is about one and a half times the weight of his food (exclusive of water). The protein, sugar, and fat which the body of a grown person takes each day weigh about 16 ounces; but the oxygen which is needed to oxidize the food is about 24 ounces. Eating more food than the body can oxidize is one of the greatest hindrances to proper respiration.



WEIGHTS OF OXYGEN AND OF FOOD

The oxygen used in the body daily weighs more than the protein, sugar, and fat that are oxidized.

If the amount of oxygen is not sufficient to oxidize the food, the waste substances are only partly formed, and are harmful and poisonous, like the smoke of a lamp that burns poorly. Imperfect oxidation, or *suboxidation*, causes diseases of the kidneys, dullness of the mind,

and sickness of the stomach. It also causes the body to become fat, because some of the food and flesh are not oxidized.

There are two means of preventing or curing suboxidation:

1. By increasing the amount of oxygen which is taken into the body.

2. By decreasing the amount of food.

The only way to increase the intake of oxygen voluntarily is to take exercise. If a large amount of food is eaten, it will be oxidized if hard exercise is taken. But many persons cannot take exercise because they sit still all day at their work. These persons will oxidize their food well if they take no more than can be oxidized by the oxygen which they breathe. If, for example, a person sits still all day and takes only 16 ounces of oxygen into the body, he can oxidize about 10 ounces of food and no more. Adjusting the amount of food to the amount of exercise is one of the best means of keeping the body healthy and the mind active.

There are two types of persons in regard to their intake of food and oxygen. The first type consists of those whose chests and lungs are large, and their stomachs small. A person of this type takes a great deal of oxygen into his body, but his stomach is unable to digest as much food as the lungs can oxidize. He is likely to be active and to do much hard work; but he will not grow fat because he oxidizes his food and flesh well. He will usually be long-winded, and will

seldom have lung troubles, but he may suffer with indigestion because his stomach will often be overworked. This type of person is not likely to overeat, but he needs plenty of food which can be easily digested.

The second type of person has small lungs and a large stomach. He can easily digest more food than the lungs can oxidize, and so he grows fat. He seldom has indigestion, but he is often short of breath, and is subject to lung diseases and the troubles which go with suboxidation. He is also likely to have diseases of the kidneys, because the wastes of his body consist of half-oxidized substances which are poisonous. A person of this type should eat food which is not easily digested, in order that the small amount of food which reaches his blood may be fully oxidized.

Stooped Shoulders. — Stooped shoulders are great hindrances to breathing. If you allow your shoulders to fall forward, their weight and the weight of your arms will press upon your chest, and you will be unable to breathe freely. Take as deep a breath as you can while you sit with your shoulders bent forward and resting on your chest. Then throw your shoulders back and see how much more air you can take into your lungs.

When you sit up straight, the muscles of your back will hold your shoulders up, and will also help to raise the ribs when you take a deep breath. When you bend over your work, do not let your shoulders fall forward on your chest. Keep them thrown back and

your elbows at your side. You will then be able to breathe freely, even though you have to bend forward while you work.

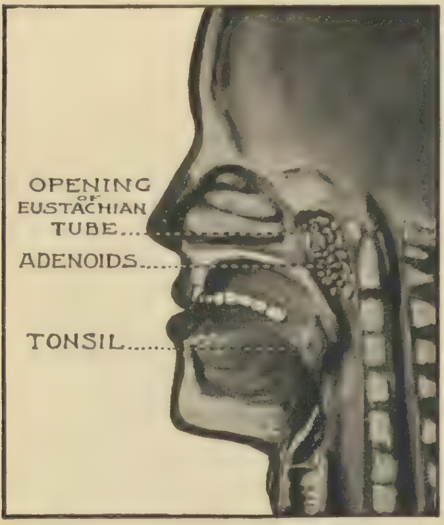
Tight Clothing. — Tight clothing is also a great hindrance to breathing. If your clothing is tight, you cannot move your chest freely, and cannot breathe deeply. Half of the movements of breathing are done by flattening the diaphragm and moving the parts of the body below the waist line. Tight clothing around the waist interferes with breathing almost as much as it would if it were around the chest.

FOLDS INSIDE OF A CALF'S NOSE

A man has the same kind of folds in his nose.

Mouth Breathing. The lining of the nose is crumpled into folds, and is moistened with mucus. As air passes over the folds, it is warmed and moistened, and most of the dust and disease germs which may be in it is caught in the mucus. If the air passes through the mouth, it enters the lungs cold and dusty. Mouth breathing is harmful to the lungs, and is the cause of a great deal of ill health.

Every person will naturally breathe through his nose if it is clear and open. If he breathes through his mouth, it is because his nose is partly stopped up. A stopped-up nose always feels uncomfortable, and breathing through the mouth requires an effort. A child at school cannot put his mind upon his lessons if he has to think about his breathing every moment.



MODEL OF THE NOSE AND THROAT

It shows how the nose and throat would look inside if the head were opened in halves.

Your nose may be stopped up with mucus. If this is so, remove the mucus by blowing it out.

If your nose remains stopped up after blowing it lightly two or three times, the stoppage is probably caused by a swelling of its lining. This swelling is usually due to an extra amount of blood in the nose. Blowing the nose hard will send more blood to it, and will make the swelling worse. You can make the swelling go down by blowing out all the breath that you can, and then waiting as long as you can before you take another breath. The chest, in trying to expand, will

draw blood away from the head. The blood tubes of the nose will then be emptied, and the swelling of the lining will go down.

Adenoids. — Mouth breathing is often caused by masses of soft flesh, called *adenoids* (ăd′ē-noidz), growing in the back part of the throat behind the nose. Children who hold their mouths open while they breathe, and who snore in their sleep, nearly always have adenoids. What is called *catarrh* is usually due to adenoids. They are often the cause of colds, sore throats, and deafness. They can be removed as quickly, safely, and painlessly as a tooth can be pulled. Their loss does not produce any bad effects, for they are of no use to the body. After a child has had his adenoids removed, there is nearly always a remarkable improvement in his health, strength, and appearance.

ADENOIDS AND TONSILS

(Natural size.) These were taken from the throat of a three-year-old boy. The lower figures are tonsils which contain many holes.

Enlarged Tonsils. — Two round masses of flesh, about the size of walnuts, may extend from the sides of the throat and almost meet over the back of

the tongue. These masses are called *enlarged tonsils.* They interfere with breathing and speaking, just as if marbles were held in the throat. They are nearly always full of holes in which disease germs often lodge and grow, producing the bad form of sore throat called *tonsillitis.* Those who have enlarged tonsils nearly always have adenoids. The tonsils may be removed with as much benefit as adenoids.

Artificial Respiration, — Expiration

The Schaefer method. Press upon the ribs to force the air out of the lungs.

Artificial Respiration. — A person who has been nearly drowned may be brought back to life by causing air to pass into and out of his lungs, as in natural breathing. Causing a person's chest to move in imitation of natural breathing is called *artificial respiration.* If you know how to do artificial respiration, you may be able to save the life of a half-drowned person when no one else is near.

Nearly all methods of doing artificial respiration depend on the elasticity of the walls of the chest. The ribs lie naturally in a position halfway between inspiration and expiration. Pressing upon the ribs reduces the size of the chest, and expels air from the lungs.

When the ribs are released, they spring up and produce an inspiration as in natural breathing.

A standard method of doing artificial respiration is as follows:

Place the nearly drowned person on the ground or floor with one arm above his head and the elbow bent. Rest his head upon the forearm with his face turned away from his elbow.

ARTIFICIAL RESPIRATION, — INSPIRATION
Stopping the pressure lets the ribs spring up and suck air into the lungs.

Kneel astride the person's thighs, facing his head. Place your hands upon the body, one on each side, just over the lowest ribs.

Bend forward and bear the weight of your body upon your hands as they press upon the ribs (picture on page 144). This produces an expiration. Hold this position long enough to say, "Out goes the water."

Suddenly press forward with your arms and throw your body upright, lifting your hands from the ribs (picture above). As you lift the hands, you can hear air rush into the lungs. Remain in the upright position long enough to say, "In goes the air."

Make these two motions as often as you repeat the

two sentences in a natural way. Bend forward as you say the word "Out," and sit upright when you say the word "In."

Continue the movements until the person breathes naturally, even if it takes an hour or two.

Practice these movements on a companion, and let him do them on you. If you do this, you will know how to do the movements when there is need, and will also learn how to avoid using a harmful amount of force.

A pulmotor is a machine for doing artificial respiration, but it is no more efficient than the method just described. If you have the opportunity to help a drowned person, begin to do artificial respiration at once, without waiting for a pulmotor or a doctor.

Electric Shock. — If a person has received a strong shock of electricity, his life is in danger because he cannot breathe. You may be able to save his life by doing artificial respiration.

Alcohol and Oxidation. — Alcohol will readily unite with oxygen and will burn with a hot flame. An alcohol lamp burns alcohol which is drawn up a cotton wick. The wick hardly burns at all, for oxygen unites with the alcohol instead of the cotton of the wick.

When alcohol enters the body, it becomes oxidized quickly, and uses up the oxygen which would otherwise oxidize food and flesh. Therefore its use deprives the body and its food of oxygen and produces the same harmful effects that breathing too little oxygen will produce.

QUESTIONS

What is the weight of food which is taken into the body daily? What is the weight of the oxygen?

What is suboxidation?

How may wrong eating interfere with respiration?

What has oxidation to do with the stoutness or thinness of a person?

How do stooped shoulders interfere with breathing?

How does tight clothing interfere with breathing?

How long will a deep breath of air last the body?

What harm comes from breathing through the mouth?

What are three common causes which prevent a person from breathing through the nose?

How can you cause your nose to become open when it is stopped up?

What are *adenoids?*

What harm do adenoids do?

How can you get rid of adenoids?

What are *enlarged tonsils?*

What harm do enlarged tonsils do?

How can you save the life of a person who is nearly drowned?

Describe the method of doing artificial respiration.

What would you do for a person who has received a bad shock of electricity?

What effect does alcohol have on the oxidation in the body?

For the Teacher. — This chapter discusses some common causes of deficient oxidation and the means of overcoming them. A great cause of ill health, especially among grown persons, is deficient oxidation due to the intake of too much food or too little oxygen. Show the possibility of remedying the condition by either eating less food or taking more exercise.

Discuss mouth breathing and the common causes of a stopped-up nose. Adenoids and enlarged tonsils do great harm by causing mouth breathing, but they do still more by being sources of infection as described in Chapter XXV.

Demonstrate the Schaefer, or prone, method of doing artificial respiration as described in the text. Emphasize the need of making the motions with the frequency with which the sentences given are naturally spoken. A common fault in doing artificial respiration is that of hurrying so much that there is no time for the oxygen which enters the lungs to be absorbed.

CHAPTER XIII

FOUL AIR

Composition of Air. — The air which is breathed into the lungs undergoes changes which make it unfit to be breathed again. Outdoor air which is fresh and wholesome is about 20 per cent oxygen, nearly 80 per cent nitrogen, and $\frac{4}{100}$ per cent carbon dioxide. It usually contains only a small quantity of vapor of water, and is cooler than the body. Fine particles of dust and a few bacteria and mold spores are nearly always floating in it.

Breathing takes away some of the oxygen from the air and puts carbon dioxide in its place. Air which leaves the lungs is about 16 per cent oxygen, nearly 80 per cent nitrogen, and 4 per cent carbon dioxide. The quantity of carbon dioxide which is added to the air nearly equals the quantity of oxygen which is taken from it.

Air which is breathed out from the lungs is usually warmer than that which enters the lungs. It is loaded with vapor of water, and contains a small quantity of substances which give it a bad odor. The changes which breathing produces in the air are shown in the following table:

Substances and Qualities of the Air	Inspired Air	Expired Air
Nitrogen (and other gases)	Nearly 80 per cent	Nearly 80 per cent
Oxygen	20 " "	16 " "
Carbon dioxide	$\frac{4}{100}$ " "	4 " "
Moisture	Usually dry	Very moist
Odor	Usually none	Considerable
Warmth	Usually cool	Warm

Breathing has no effect on the nitrogen of the air. Pure oxygen acts in a manner which is too rapid and forcible for health. When the red-hot end of an iron wire is thrust into a jar of oxygen, the wire burns like a match and throws off showers of sparks. If a stove were set up in a room full of oxygen, its iron would burn up if a fire were started in it. The use of the nitrogen of the air is to dilute the oxygen and make it act in a mild way.

How Air is Made Impure. — The changes in air which are produced by breathing are like those which are produced by a fire. Since fires, animals, and persons are always using up oxygen and pouring carbon dioxide into the air, it might be supposed that the outdoor air would finally become impure. It does not do so, for two reasons: first, the winds carry the impurities away and bring in fresh air; and secondly, plants take carbon dioxide from the air and use it as food. Their green leaves separate the carbon from the oxygen. They give the oxygen back to the air, and use the carbon in building up their stems, roots, fruit, and

other growing parts. The quantity of oxygen which plants give to the air nearly balances the amount of oxygen which fires, lower animals, and persons take from the air.

Danger from Lack of Oxygen. — Air which is breathed out from the lungs may still support life, but it may not contain enough oxygen to support a fire, as the following experiments show:

A BURNING CANDLE IN A JAR

Experiment to show the amount of oxygen needed to support a fire.

Wind the end of a wire around a piece of small candle, such as is used on Christmas trees. Light the candle and lower it into a pint jar. It will burn about ten seconds and will then go out, because the oxidation, or burning, uses up the oxygen.

Remove the impure air by filling the jar with water and then emptying it. Take a deep breath, hold it for about fifteen seconds, and blow it into the jar. Lower the lighted candle into the jar, and it will go out at once, because much of the oxygen was removed while the air was in the lungs.

Cleanse the jar as before, take half a dozen deep breaths, and quickly blow the last one into the jar. Lower the lighted candle into it, and it will burn very nearly as long as it did in the first experiment, because the lungs did not have time to take much oxygen from the air.

The air in wells, cellars, tunnels, and other closed places sometimes contains too little oxygen to support life, and persons have been suffocated on going into them. You can test the air of such a place by lowering a candle into it. If the candle continues to burn, there is enough oxygen in the place to support life; but if the candle goes out, the place may be dangerous to life.

Foul Air in Living Rooms. — When the air of an ordinary living room is breathed over and over, it becomes noticeably foul, and a person who breathes it is likely to be dull and short of breath, and to have a headache. If the air becomes very foul, he feels dizzy and faint. When the air of a schoolroom begins to be foul, the bad effects on everybody in the room quickly appear. The pupils become restless and irritable, and cannot put their minds to their work, or think clearly. They therefore often fail in their lessons.

Breathing foul air day after day has a bad effect on the whole body. Many persons are weak, pale, and sickly because they breathe foul air during some part of the day or night. Fresh air, full of oxygen and free from the waste matters of the body, is necessary for health and strength.

A person who is shut in a small, air-tight room, such as a bank safe, would soon use up the oxygen and would be in danger of his life. But breathing the air of an ordinary living room usually cannot use up enough oxygen to make the air dangerous to life, because the quantity of oxygen in the room is large, and because fresh air can enter the room through cracks in the floors and windows. The bad effects of foul air in living rooms, meeting places, and workrooms are due chiefly to four principal causes:

1. A warm temperature.
2. Unpleasant odors.
3. Dust.
4. Disease germs.

Effects of Warmth. — Experiments have been made with students who have worked for hours in small, air-tight rooms in which the air has been analyzed and all its impurities discovered and measured. It has been found that the principal condition which produces the unpleasant feelings of foul air is heat. When a crowd goes into a room which is comfortably warm, their bodies warm the air still more, as if the persons were radiators; and the vapor of water in their breaths makes the air as damp as it is on a hot, foggy day in summer. The feelings produced by the warm, moist air of a close, crowded room are like those which are felt on a still summer day when not a breath of air is stirring. The experiments with the students showed that the unpleasant feelings produced by the close

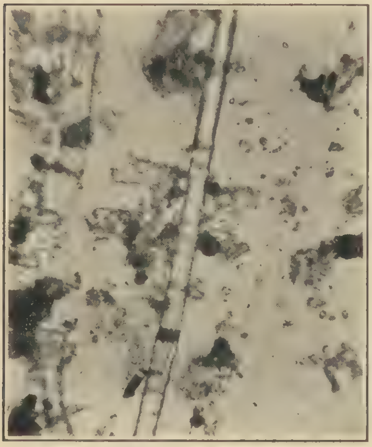
air could be relieved or prevented by keeping the air in motion, as by an electric fan, even while the air remained foul. The effect of the moving air is to cool the body as is done by a hand fan.

A comfortable temperature for a living room or meeting place is between 65° and 70° Fahrenheit. If the temperature goes above 75° F., the feelings which go with foul air usually appear, whether the air is foul or not.

Odors. — Air that has been made foul by breathing has an unpleasant odor which comes from the human body. There is a peculiar odor of the human body, just as there is one of a horse, and another of a dog. These odors become noticeable when the air is close and warm. The substances to which the unpleasant odors are due are not harmful in themselves, but the odors make a person feel uncomfortable, and do harm by preventing one from thinking and resting. The odors are given off from the bodies of persons who are clean as well as from those who are dirty. Perfumes and incense do not destroy the foul-smelling substances in the air, but they act by adding other odors which are stronger than the unpleasant ones. The only way to prevent the unpleasant odors in a living room or meeting hall is to change the air of the room often.

Moisture in Foul Air. — Expired air contains nearly all the vapor of water that it can hold. When the air is cold, the water in the breath looks like steam. Air that has been made foul by breathing is loaded with

vapor which comes from the lungs. This vapor increases the bad odor of the air and the unpleasant feelings which are produced by the foul air. If the windows of a crowded room are wet with moisture which is produced by breathing, that air is too foul to be breathed with safety.



HOUSE DUST

(Magnified 200 times.) The fibers are cotton, and the rest of the dust consists mostly of bits of wood and ashes.

Outdoor Dust. — Outdoor air always contains dust even over the ocean and on high mountain tops. Microscopic bits of dust in the air may be useful. A bit of dust is at the center of each raindrop and particle of water in a fog or cloud. If there were no dust in the air, there would be no gentle rains. But a large amount of fine dust particles, such as those of smoke, may cause dense fog.

Indoor Dust. — The air of living rooms, meeting places, and workshops often contains a great amount of dust. There are three kinds of dust, according to their effects on health:

1. The soft.
2. The hard and sharp.
3. The poisonous.

The dust in the air of living rooms and meeting halls usually consists of such substances as soil, ashes, and shreds of wood, cotton, and wool. These dust particles are nearly always soft, and do not scratch or harm the nose or lungs. When they are breathed into the body, they are caught on the moist surfaces of the nose and throat, and are driven out when the nose is blown.

Dust which is hard and sharp is formed in many workshops. The dust which is produced by stone cutting and tool grinding contains sharp bits of stone or steel which injure the air tubes and lungs, and often lead to tuberculosis. There are two means of protecting workmen against harmful dust: (1) Hoods and suction pipes, which carry the dust away from the material on which the work is done, and prevent it from flying into the air. (2) Respirators worn by the workmen, which strain the dust from the air to be breathed.

Dust which is poisonous may be produced in some trades, such as lead working. This dust may be kept out of the body by the use of suction pipes and respirators. It is also necessary that workmen wash their hands and faces before eating in order that none of the poisonous substances may reach their food.

Disease Germs in Foul Air. — One of the greatest dangers from foul air is that of disease germs which may rise with dust. If a person has a cold, or tonsillitis, or diphtheria, or other disease which is catching,

he will expel disease germs with tiny drops of saliva and mucus from his nose and throat when he coughs, or talks, or sneezes, or blows his nose. The drops quickly dry, and their germs rise with the dust of the room and float in the air, and may then enter the bodies of other persons who breathe this air. Millions of germs fly off from every dried collection of mucus which is spit upon a floor or pavement.

Wherever many persons meet, some one who has a cold or other infectious disease is likely to be in the room. For this reason the foul air of houses and meeting places nearly always contains disease germs. A common way in which a cold, or a sore throat, or pneumonia, or tuberculosis is caught is by breathing air which has been made foul by some one who has the disease.

Each pint of foul, dusty air of a crowded room or meeting place may contain fifty bacteria, and many of the bacteria are likely to be disease germs. Less than five bacteria may usually be found in a pint of outdoor air from a dusty city street, and if the streets are wet, the outdoor air will contain hardly any bacteria at all.

It is almost impossible for you to catch a disease by breathing outdoor air unless the air is full of dust from a dirty street. If you keep a room supplied with clean outdoor air, you will not catch a cold or any other disease from the air, for there will be hardly any disease germs floating in it.

Effect of Lights. — Lights which are produced by burning use up oxygen, warm the air, produce odors,

and make the air foul, just as breathing does. A candle uses about as much oxygen as a man. A bright light made by burning kerosene or gas uses about as much oxygen as five or ten men. Electric lights do not use oxygen or make the air foul, for their light comes from white-hot wires which lie inside of air-tight glass globes. Electric lights are usually the most healthful of all the means of lighting houses.

How to Tell Foul Air. — The air of a room is considered to be fresh, pure, and healthful when it is like the outdoor air on a mild, pleasant day. Three tests which any one can apply to air are those for odors, temperature, and dust. A fourth test is one for carbon dioxide, but that requires a laboratory equipment and a skilled observer.

An unpleasant human odor in the air is one of the best signs that the air is foul. After breathing foul air for a few moments, you may become used to the smell, and may no longer notice it, but the air is then as unwholesome as ever. If you are not sure about the freshness of the air of your room, step out of doors for a moment. If you can notice an unpleasant odor when you come back into the room, the air is foul and unfit for breathing, and needs to be changed for fresh air from out of doors.

A thermometer in a room will indicate the temperature of the air. One can watch the temperature of the air of a room and regulate it by means of fires and windows.

Dust in the air of a room can be seen and often smelled when it is abundant.

Carbon Dioxide Test. — One may easily collect air to be examined for carbon dioxide by carrying a large glass bottle filled with pure water into a room, pouring out the water, and corking the bottle tightly. The air in the bottle is that from the room, and can be used for a laboratory test.

When the amount of carbon dioxide in a room is doubled by breathing, the air begins to have an unpleasant odor; and if there are many persons in the room, the temperature of the air begins to rise. When the amount of carbon dioxide is increased to ten or fifteen times its quantity in outdoor air, the air of the room has an offensively foul odor.

Carbon Monoxide. — When a fire burns with a poor draft, it often gives off a half-burned gas, called *carbon monox'ide.* This is the gas which is often called coal gas. When a small amount of carbon monoxide is present in air which is breathed, it produces dizziness and headache. Larger amounts produce faintness, unconsciousness, and even death. It acts by uniting with the red blood cells and preventing them from carrying oxygen through the body.

Carbon monoxide is one of the principal things in illuminating gas, and is often produced in stoves which burn coal, or charcoal, or kerosene oil. A gas stove, or oil stove, which is not connected with a chimney, may endanger health by pouring carbon monoxide into the air.

Carbon monoxide is also found in the exhaust gases of automobile engines, and has often poisoned those who were in a closed room in which an automobile engine was running. The gas itself has no odor, but other substances which are formed with it have unpleasant odors, like those of illuminating gas, which give warning of danger. If there is the least smell of gases in a room, the air is dangerous to health and possibly to life.

A SOURCE OF DANGER

Keep the garage door open while the engine runs, so as to remove the carbon monoxide which is in the exhaust gases.

QUESTIONS

What is the composition of outdoor air?

What changes are produced in air by breathing?

By what means is the composition of the outdoor air kept almost constantly the same?

What changes occur in the air of a living room or meeting place as the result of persons being in the room?

What effect does air which is made foul by breathing have upon a person?

How can you show that the air which comes from the lungs during quiet breathing will not support a fire?

What is the difference between the breath of a person blowing a fire and the expired air of quiet breathing?

What are the four principal causes of the bad effects of ordinary foul air?

At what temperature does the air of a room begin to feel close and warm?

How can you detect foul air by means of the sense of smell?

What kinds of dust are unhealthful?

By what two methods may workmen be protected from unhealthful dust?

When may you expect to find disease germs in the air?

What are the effects of lights upon the purity of the air of a room?

What is the danger from an automobile engine which is running in a closed room?

For the Teacher. — Many experiments have been made to find out the causes of the bad effects of air which has been made foul by breathing. Deficiency of oxygen and an increase in carbon dioxide were formerly believed to be the harmful conditions, but experiments prove that a person will not be affected by these conditions so long as the air contains enough oxygen to support a fire. Perform the experiments with a burning candle in a jar.

It will probably confuse the pupils to dwell too much on the various theories regarding the cause of the bad effects of ordinary foul air such as that in a close schoolroom. Four conditions which have definite effects are:

1. Warmth.
2. Odors.
3. Dust.
4. Disease germs.

Warmth is the principal condition which produces discomfort, and bad odors are second. Emphasize the means of testing the purity of air by means of its odor. This is a reliable test, and may be applied quickly by any one.

Demonstrate also the test of taking the temperature of the air by means of a thermometer.

The carbon dioxide test is practicable only when a well-equipped laboratory is available.

Dust is especially dangerous when it comes from stone or metal. Ordinary house dust is dangerous when it comes from an unclean room which is occupied by a careless person who has an infectious disease, for it may then contain disease germs.

Emphasize the topic of carbon monoxide poisoning; the danger from the presence of this gas in the exhaust from automobile engines; and the need of ventilating a garage in which an automobile engine runs for only a moment.

CHAPTER XIV

VENTILATION

Keeping Air Wholesome. — There are five methods of keeping the air of a room pure and wholesome:

1. By changing the air often.
2. By regulating the temperature of the air.
3. By cleaning the room.
4. By keeping the room in good repair.
5. By admitting plenty of sunshine into the room.

Ventilation. — Exchanging the impure air of a room for pure and fresh air is called *ventila'tion.* A small room will require a complete change of air within an hour if only one person is in it. A large room will require a complete change of air within a few minutes if many persons are in it. A schoolroom, church, or other meeting place needs to be ventilated all the time that it is in use, for the air will become unwholesome within a few minutes unless a stream of fresh air is constantly flowing into it.

Reckoning How Much Fresh Air is Needed. — You can easily reckon how much fresh air a person needs. Suppose you were shut in an air-tight room which measures 10 feet square and 10 feet high. How long

could you stay in the room before the air would become foul?

Air is foul when the amount of carbon dioxide is double that in outdoor air (p. 158). The room contains $10 \times 10 \times 10$, or 1000 cubic feet.

Since $\frac{4}{100}$ per cent, or 0.0004 of the outdoor air is carbon dioxide (p. 149), the amount of carbon dioxide in the room is $1000 \times 0.0004 = 0.4$ cubic foot = 691 cubic inches.

If another 691 cubic inches of carbon dioxide is added to the air, the air will be foul.

Since there are 30 cubic inches of air in each breath of quiet breathing (p. 136), and 4 per cent of expired air is carbon dioxide, the amount of carbon dioxide in each breath is $30 \times 0.04 = 1.2$ cubic inches.

Since 1.2 cubic inches of carbon dioxide is given off with each breath it will take $\frac{691}{1.2}$, or 576, breaths to produce 691 cubic inches of carbon dioxide and make the air foul.

Since 20 breaths are taken each minute, it will take $\frac{576}{20}$, or 29, minutes to make 1000 cubic feet of air foul.

This problem shows that a person makes 1000 cubic feet of air foul each half hour. It also shows that each person in a room needs 2000 cubic feet of fresh air each hour in order to keep the air fresh and pure.

How to Ventilate. — Some air will pass into and out of a room through cracks in its doors, windows, floor,

and walls. Well-built houses have few cracks, and only a little fresh air will enter them, unless openings are made to the outdoor air.

One way of ventilating a room is to open a window. This is often the only way to get fresh air into a room.

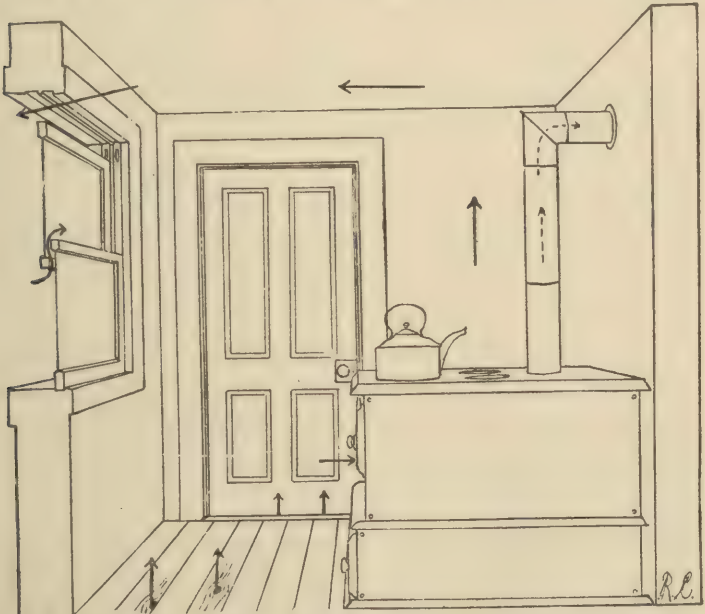


Diagram of the Natural Ventilation of a Room

The arrows show the natural direction of the currents of air.

It is easy to ventilate a room that is heated. Warm air is lighter than cold air, and will rise to the ceiling, like a cork on water. When the upper sash of a window is lowered, a stream of foul air passes out above it. Fresh air enters the room between the two sashes,

and through cracks in the other parts of the room. If foul air passes out of the room, we may be sure that other air enters the room.

When the lower sash of a window is raised, foul air sometimes passes out through the opening, and sometimes fresh air blows into the room through the opening, but whether the foul air blows out, or fresh air blows in, the air of the room becomes changed.

Ventilators. — Many houses, schools, churches, and other meeting places have openings in the ceilings leading to attics, or to large pipes which open above the roofs like chimneys. These openings carry off the foul air, while fresh, cool air enters through the doors and windows.

In large buildings, fans are often placed in the basements to force fresh air through the rooms. In this way the amount of air sent into the room may be regulated, and the air of the room may be kept perfectly pure.

Ventilating Bedrooms. — Some persons think that a bedroom does not need to be ventilated during the night if it is aired well during the daytime. A person sleeping in a small, closed bedroom will cause the roomful of fresh air to become foul within an hour after he goes to bed. He will then breathe foul air through all the rest of the night, unless he ventilates the room.

Many suppose that a person will not be harmed by breathing air which he himself has made foul. Im-

pure air is as poisonous to the person who makes it foul as it is to another person who may breathe it.

Sleep with your bedroom window open all night long. If the air is cold, use plenty of bedclothes, and you will sleep comfortably and healthfully, and awake refreshed.

Sleeping on an outdoor porch will induce rest and promote health and strength. Outdoor sleeping is one of the best means of restoring health to those who have tuberculosis.

The Arithmetic of Ventilation. — If twenty persons are in a room, how wide should the windows be opened in order to keep the air of the room fresh?

The quantity of fresh air which should enter the room each hour is at least 40,000 cubic feet, whether the room is large or small, for each person needs 2000 cubic feet of fresh air each hour.

A gentle current of air that barely shakes a curtain will move about four feet a second, or about as fast as a man walking rather slowly. If air flows at that rate through a window three feet wide, which is opened four inches, four cubic feet will pass through the opening in one second, 240 cubic feet in a minute, and 14,400 cubic feet in an hour. Therefore, three windows will have to be kept open four inches in order to supply the 40,000 cubic feet of air per hour which twenty persons need. If the air currents move rapidly enough to make a cold draft across the room, or to blow the curtain aside, smaller openings may supply a

sufficient quantity of fresh air. If the outdoor air is warm and still, larger openings will be required.

Drafts. — Many persons do not ventilate their rooms and meeting places during cold weather because they fear that drafts will produce the forms of sickness called colds. A cold is caused by disease germs which come from other sick persons, just as measles comes from germs which another person gives off from his body. If a person gives off the germs of a cold to the air of a room, any one who breathes the air may take the germs into his nose and throat, whether there is a draft in the room or not. The time to open a window and begin to ventilate is as soon as any one comes into a room, and before the air becomes foul. If the air of a room is pure and fresh, there will be no disease germs in it and a person will not catch a cold from breathing the air.

It is nearly always possible to ventilate a room without producing drafts. One way is to drop the upper sashes of the windows on the side of the room which is opposite to that on which the wind blows. The main stream of air will then flow out of the room, and fresh air will enter in many small streams through cracks in the doors and windows.

Another way is to tack a sheet of thin muslin to a frame, and place it in an open window as you would a mosquito screen. This will allow fresh air to enter the room, but will prevent it from blowing across the room in a draft.

Ventilation for Coolness. — Attention to the temperature of a room is necessary in order to keep its air comfortable. A common fault in winter is that of heating the air of a room as warm as the outdoor air on a hot day in summer. It is often necessary to open the windows of a meeting hall or schoolroom in order to keep the air comfortably cool.

Bacteria in Dust. — One of the principal reasons why foul air is dangerous is that persons who breathe the air stir up dust and disease germs from the floors, carpets, and furniture. If a room is clean, only a little dust and very few bacteria will rise into the air. Keeping a room well swept and dusted will prevent a great deal of sickness.

Sweeping and Dusting. — While you are sweeping a room, open its outside doors and windows so that the dust will be blown away. When you dust the furniture use a moist cloth; this will hold the dust and prevent its being scattered through the air again.

Sweeping will not remove all the dirt from carpets which are tacked down to the floor, for a broom will remove only the dirt which is on the surface, and will not take out the dirt and dust which lie among the threads, or under them. Rugs are more healthful than carpets, for they may be taken up and cleaned.

A vacuum cleaner is an excellent thing for cleaning carpets and cushions, for the dirt and dust are forced up from among the threads, and held in a tight box from which they cannot escape into the air.

State of Repair of Floors. — Dirt collects on a rough floor and in cracks between the boards, and dust rises from the floor when any one walks across the room. Keeping the floor of a room in good repair is necessary in order to prevent dust and the unpleasant odors of dirt in the air of a room.

A floor which is varnished or painted is hard and smooth, and dust and dirt may be easily removed from it. The floors of schoolrooms and other meeting places are likely to be worn and soiled by the feet of many persons walking across them. Oil is an excellent thing for these floors, as it will help to harden the floors and will prevent the rise of dust from them.

Sunshine in a Room. — Disease germs will often stay alive for days and weeks in dark, damp corners of rooms and closets, but sunlight will dry a room, and will also kill the disease germs which may be in it. Sunlight, cleanliness, and fresh air are the best of all means for making a room healthful.

Many old houses have rooms which do not have a single window opening into the outside air. These rooms are breeding places of disease, for they receive neither light nor fresh air. Most cities now have laws that every room in a house shall have windows opening into the outside air. There are also laws that large air shafts shall be left open between crowded buildings, so that every room may get air and light. But education is needed in order to impel the people to make use of the air and light.

QUESTIONS

What is ventilation?

How much fresh air does each person need in an hour?

How can you ventilate a room?

How does heating a room help to ventilate it?

When should you begin to ventilate a room in which a crowd gathers?

How rapidly may a current of air move through a window without making a strong draft?

How can you reckon how wide to open the windows of a room in order to ventilate it properly?

How can you prevent a draft in a room while ventilating it?

Why should you keep a window of your bedroom open all night?

How should you sweep and dust a room?

Why is a vacuum cleaner an excellent machine to use for cleaning a room?

How do painting and repairing a floor help to make a room healthful?

Why are rugs more healthful than carpets?

How does sunshine help to make a room healthful?

Why do cities have laws regulating the number of windows in a room?

For the Teacher. — Coördinate this lesson with arithmetic. Reckon the amount of fresh air which a person needs each hour. Also reckon the inflow of fresh, cool air through a window.

Demonstrate methods of ventilation by means of windows. Test the direction and force of the flow of air in ventilation by holding a lighted candle near an open window, and in various other parts of the schoolroom. Emphasize the benefit of keeping the windows of a bedroom open at night.

Discuss drafts, — the unwise fear of them, and methods of preventing them.

Demonstrate methods of sweeping and dusting by which dust is not scattered through the room.

The peppery, pungent odor in the air of closed, unoccupied rooms is usually caused by molds growing on the floors and carpets.

CHAPTER XV

BODY HEAT

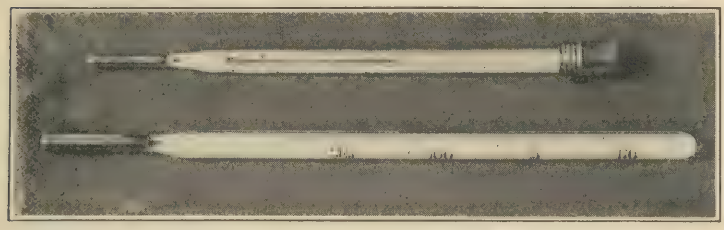
Source of Body Heat. — The body is nearly always warmer than the air around it. Its heat is produced by the oxidation, or slow burning, of its food and flesh (p. 133). When food and flesh are oxidized in the body, they yield the same amount of heat that they would produce if they were burned outside of the body.

The oxidation takes place more rapidly in some parts of the body than in others. It is rapid in the liver and in the muscles while they are at work; and it is very slow in the bones and skin, and in the hands and feet. But the blood takes the heat from the liver and muscles and carries it to the skin, the hands, the feet, and all the rest of the body; and so it keeps all parts of the body at nearly the same warmth. The body is warmed by the blood in the same way that a house is heated by a hot-water system. The blood is like the hot water which carries heat from the furnace to the radiators in the rooms. When your hands are cold, you can warm them by making the blood flow through them rapidly, as by clapping them together or whipping them around your back.

Measuring Heat. — The heat of the body is measured in two ways:

1. Its hotness in *degrees of temperature.*
2. Its quantity in *calories.*

The difference between temperature and amount of heat may be illustrated by a match and a pailful of warm water. A burning match has a high degree of temperature, but the pail of warm water contains a thousand times more heat than the match.



TWO THERMOMETERS USED FOR TAKING THE TEMPERATURE OF THE BODY

The upper one is shown as indicating the natural temperature of the healthy human body.

Thermometer. — Degrees of temperature are measured by means of a *thermom'eter.* When a doctor examines you, he usually takes your temperature by placing a thermometer under your tongue for a minute or two. If you are in good health, your temperature is about 98½ degrees on a Fahrenheit thermometer, and we write it 98.5° F. If your temperature is less than 98° F., you are cold or chilly. If it is 100° F., or more, you have a fever and are sick. A temperature of 104° F. is a high fever and a sign of severe sickness.

A fever is usually caused by disease germs growing in the body.

Calories. — If heat is put into an object, that object becomes warmer and its temperature rises. A *calorie* (sometimes called "large calorie") is the amount of heat which will raise the temperature of one kilogram of water one degree Centigrade, or one pint of water about four degrees Fahrenheit. It takes about fifty calories to heat a pint of ice-cold water boiling hot. One can measure the amount of heat which a substance can produce by burning a small amount in a cup that is surrounded by water, and seeing how many degrees it warms the water. An ounce of sugar or of protein will produce 120 calories, and an ounce of fat, 240 calories.

The body of a grown person doing light work needs about 2400 calories in a day in order to keep its temperature at 98.5° F. The oxidation of food in the body produces heat about as fast as two burning candles. An ordinary candle weighs about one ounce. It will burn about 4 hours and will produce about 240 calories of heat. It will take 6 candles lighted one after another to keep burning 24 hours, and they will produce 6 times 240, or 1440 calories. Twelve candles, enough to keep burning two at a time 24 hours, will produce 2880 calories, which is only a little more than the amount of heat that a grown person usually needs in a day. You will need to know about calories in order to study foods, because one of the principal ways to

judge the value of a food is by the number of calories which it will yield to the body. The value of coal or other fuel is also judged by the number of calories which it will produce when it is burned.

Regulation of Body Temperature. — Your body does not produce the same amount of heat at all times. It produces much heat while you are running, and only a little while you are sitting still; and yet if you are healthy, the temperature of your body remains 98.5° F. You may feel too warm while you run, but your body is then no warmer than it is while you sit still and are comfortably cool.

The body regulates its temperature in two ways:

1. By the touch of the cool air around it.
2. By the perspiration.

Cold Air. — The body is always losing heat to the air which touches it, if the air is cooler than the body. If the air is cold, it cools the body rapidly, but if it is warm, it cools the body slowly, or not at all. The skin is like the radiator of an automobile, and the blood is like the water which flows through the radiator. When the air is cold, or when one sits still and produces only a small amount of heat, the blood tubes of the skin contract, the skin becomes pale, only a small quantity of blood flows near the cold air, and so the body saves its heat. But when the air is warm, or much heat is formed, the blood tubes of the skin expand, the skin becomes red, and a great deal of blood flows near the air in order that the heat may pass off rapidly.

Some animals lose their heat almost as fast as they produce it. The temperature of fishes, frogs, snakes, and insects is nearly the same as that of the air or water in which they live. These animals are *cold-blooded*. They are active while the air or water is warm, but are sluggish and almost lifeless when the air or water is cold.

Cold-blooded land animals, and some warm-blooded animals, such as woodchucks, lie under the soil or in the mud all through cold weather, and appear almost lifeless until the warm spring weather. The long winter's sleep of these animals is called *hiberna'tion*.

Whales and seals are warm-blooded animals which live in the water. Although the water may be almost freezing cold, yet the temperature of these animals is as high as that of man, because a thick layer of fat under their skins prevents the heat of their bodies from passing off to the water.

Cooling by Perspiration. — When the air is very warm or hot, it does not cool the body by its touch, and yet the temperature of a healthy body does not rise, because the perspiration cools it. A teakettle will illustrate the way in which perspiration cools the body. When a kettle of cold water is placed over a fire, the temperature of the water rises until it reaches 212° F., and the water begins to boil. The temperature of the water then remains at 212° F., because the steam carries away all the heat that goes into the water.

When you perspire, the water of the perspiration becomes a vapor and carries away the heat that would

warm the body above 98.5° F. Some perspiration is always passing off and cooling the body, even on a cold day of winter. Touch your dry finger to a cold glass. A spot of vapor on the glass will show that perspiration is passing off from your skin. When the day is hot, a great deal of perspiration is formed in order to cool your body.

The perspiration is the principal means of cooling the body on a hot day. You are in no danger from heat as long as you perspire freely; but when you lose a great deal of water and can no longer perspire, the temperature of your body quickly rises, you have a fever, and are weak and faint. This sickness is called a *sunstroke*, or a *heat stroke*. You need to drink much water on a hot day so that you will perspire freely and keep your body cool. Water that is somewhat cool will cool your body as well as ice water, for it is the perspiration, and not the coldness of the water, which cools you.

Humidity. — Air contains vapor of water. When the air contains only a little water, it takes water from wet objects, and so it makes them dry. When air contains all the water it can hold, as on a foggy day, wet objects do not become dry, because the air cannot take up their water. The wetness or dryness of the air is called its *humid'ity*.

If there is a great deal of water in the air, it affects the body in three different ways, which vary with the temperature:

1. This moisture is uncomfortable and harmful to the body when the air is very warm.

2. It often adds to the comfort of the body when the air is just comfortably warm.

3. It feels uncomfortable and chilly when the air is cold.

If the air is hot and full of water vapor, the perspiration does not dry from the skin, the body is not cooled, and its temperature may rise until there is a fever. If the air is dry, perspiration dries from the skin rapidly and cools the body even when the air is hot. A person can stay in a hot oven safely so long as he perspires freely.

You suffer from the heat greatly on a warm, humid day in summer. You suffer in the same way from the heat in winter when your living rooms and meeting places are poorly ventilated, because the air of heated, unventilated rooms is often as hot and moist as outdoor air on a hot summer's day. Many of the bad effects of impure air are caused by the heat and moisture of the air, and these may be prevented by ventilation (p. 152). If the windows of a heated room on a cold day are wet with vapor which comes from the air, the air is usually too hot and moist for comfort and health, and the room is in need of ventilation.

The most comfortable temperature of the air of a living room is about 70° F. (p. 153). If the air at that temperature is very dry, it takes up perspiration rapidly, and is likely to make the body feel cold. But if the air is moist, it does not take away the perspiration, the body loses little heat, and one feels warm. Moist air at a

temperature of 65° F. feels as warm as dry air at 70° F. When you heat a room in winter, you can save heat by making the air moist. Place a pan of water on the stove or radiator so that its vapor will pass into the air. If you have a hot-air heater, keep its water box filled.

Cold air which is damp and foggy takes heat from the body more rapidly than that which is dry. A damp wind that is just above freezing makes you feel colder than a dry wind which is much colder than freezing. You judge the coldness of the air by its dampness as well as by its temperature. If the day is damp and foggy you need to wear more clothes than when the air is dry.

Taking Cold. — It used to be supposed that coldness was the cause of the kinds of sickness which are called *colds*. It is now known that colds are caused by disease germs which come from other people, and from foul air and dust. Air which is cold and damp has no more disease germs than air which is warm and dry. On cold or damp days, people keep their doors and windows closed, and the air of their houses becomes foul and full of disease germs. They then catch cold by breathing the foul air when they go into the house to warm and dry themselves. Coldness and chills do not make a person take cold unless he takes living germs of the sickness into his body.

There is a way by which coldness and dampness may help a person to catch cold when he takes disease germs into his body. Cold air blowing upon the body may

weaken it so much that the white blood cells cannot destroy disease germs when they enter the body (p. 96). If the body is chilled, the white blood cells may not be able to destroy the disease germs which they are usually able to overcome. But there must be disease germs in the body before a cold can develop. Remember also that disease germs in the body may cause a cold whether the body has been chilled or not.

Weather. — Some persons think that during bad weather the outdoor air contains something which is likely to make them sick, and so they shut the air out of houses on unpleasant days. Most diseases which are supposed to be due to bad weather are caused by disease germs in the foul air of houses and meeting places, and not by the outdoor air.

Weather and climate consist principally of four conditions of the outdoor air:

1. Temperature.
2. Motion, or the wind.
3. Dampness, such as rain or fog.
4. Sunshine.

The principal direct effect which weather has on health is that it produces changes in the temperature of the body. But man can easily protect himself against unpleasant weather by means of houses and clothes.

Voluntary Regulation of Temperature. — There are four principal ways by which one can help to keep the body comfortably warm:

1. By heating houses and living rooms.
2. By clothes.
3. By exercise.
4. By food.

Heating Houses. — When the temperature of the outdoor air is below 60° F., living rooms usually need to be heated. Some persons close their heated rooms tightly in order to save heat, and when they do so the air soon becomes foul. It would be easy to heat a house if it were not for ventilation.

There are five principal means of heating houses, namely: fireplaces; stoves; gas or oil heaters; a hot-air furnace; and steam or hot-water radiators.

The principal difference in the healthfulness of these five means of heating is in their effects on ventilation. A fireplace causes a strong draft of air to rise up the chimney, and so it ventilates a room. A stove does not ventilate a room nearly so much as a fireplace does.

A heater which burns gas or oil pours its waste products into the air and makes the air foul, unless it is connected with a chimney. Electric heaters are healthful, for no burning takes place in them and they do not make the air foul.

A hot-air heater warms a house by means of a stream of air which passes over the hot furnace and into the rooms. It ventilates a room while it heats it. The air will usually be too dry unless the air is kept moist (p. 176). Rooms that are heated by steam or hot

water need to be ventilated because the radiators do not bring fresh air into the house.

Clothing. — Clothes keep the body warm because they prevent heat from leaving the body. They do not make heat, but they help to hold that which is produced by oxidation. They hold the heat by two means:

1. The cloth itself.
2. The air which is held in the fibers and layers of the clothes.

The air in clothes is almost as important as the cloth of which clothes are made. Clothes which fit tightly are cold, because the air is crushed out from among the fibers. Clothes which fit loosely are warmer than tight ones; two or three thin garments, than one thick one; and cloth loosely woven, than that which is firm and hard.

Wear enough clothes to keep you warm. Prepare for cold weather and storms so that you can keep all parts of your body both warm and dry.

Wet Clothing. — If clothes are wet, the heat of the body causes the water to dry from them, and the vapor takes away heat and makes the body feel cold. Damp clothes are harmful when they cool the body. They will not usually harm the body during exercise, for the exercise will keep the body warm. They are harmful when a person sits still, for they may then cool the body more rapidly than the body can replace the heat.

Exercise. — When the muscles are exercised, food or flesh is oxidized, and heat is produced. One fourth of

the heat is turned to power which gives the body strength to work. Three fourths of the heat goes to warm the body, and does not add to the strength or power to work. Exercise makes the body warm. Al-

WARMING THE BODY BY EXERCISE

When you take exercise, one fourth of the heat of oxidation is used up as power, and three fourths goes to warm the body.

most the only way to increase the amount of heat which the body produces is to take exercise. A person can easily keep warm in the coldest weather by exercising.

When the body is cold, its muscles contract, and tremble or shiver. The contraction of the muscles produces heat, and so shivering helps to warm the body.

Cold muscles cannot act well, and cold nerves cannot feel. When your hand is cold, it has no strength and

is numb. If you whip your cold hands together, or around your shoulders, you send warm blood through them and restore their warmth, strength, and feeling.

Food. — When the weather is cold, you need plenty of food in order to carry on oxidation and produce heat enough to keep the body warm. One reason why the Eskimos can live in the cold north is that their most abundant food is fat meat, which produces a great deal of heat. A wild bird or animal can endure severe cold if it has plenty of food to keep up the oxidation in its body. You will not mind the cold if you have plenty of food, and exercise hard in the cold air out of doors.

QUESTIONS

What produces the heat of the body?

Compare the method of heating the body with a hot-water system of heating a house.

What is the natural temperature of the body?

What is a *fever?* What is usually its cause?

What is a *calorie?*

How many calories does the body need to produce in a day?

In what two principal ways does the body regulate its temperature?

How does the perspiration cool the body?

What is the cause of a heat stroke?

What is the meaning of the word *humidity?*

Why does moisture in the air increase the feeling of warmth on a warm day, and of coldness on a cold day?

What is the most comfortable temperature for the air of a room?

Why does moist air at a temperature of 65° F. feel as warm as dry air at a temperature of 70° F.?

What has cold weather to do with one's catching a cold?

What conditions of the air make up the weather?

Compare the healthfulness of the various methods of heating houses.

How does clothing keep the body warm?

What has the air in clothing to do with keeping the body warm?

How does exercise help to warm the body?

How does food help to warm the body?

For the Teacher. — Animal heat is popularly supposed to be a mysterious thing, and changes in the temperature of the body are blamed for infectious diseases and all manner of pains and aches. In this chapter the ordinary laws of physics are applied to the subject of body heat.

Emphasize the topics of the source of the heat of the body, and its measurement in degrees of temperature and in calories. Develop the concept of a calorie in some detail, for it is at the basis of a common method of judging the value of foods. The calorie (or large calorie) used in measuring food values is 1000 times as great as the calorie, or small calorie, used in physics.

Teach the various degrees of temperature which are often mentioned in hygiene, such as the freezing point, the boiling point, the temperature of a healthy person, a fever temperature, and the most comfortable temperature of a room.

Explain the two methods by which the human body automatically regulates its temperature; and show how man augments these methods by heating houses, by clothes, by changing the humidity of the air of houses, by exercise, and by food.

Dwell upon the four elemental conditions which go to make up what is called weather and climate; and show how the weather of a room on a winter's day may be as hot, humid, and uncomfortable as the outdoor air on a hot, moist day of August.

Emphasize this truth, that the essential factor in taking cold and catching diseases is the taking of disease germs into the body; and that cold, heat, dampness and other conditions of the air, soil, and weather are causes which are less important than infection.

CHAPTER XVI

THE SKIN

The body is wrapped in a soft skin which is as thick and strong as that of a dog or a calf. Pinch your skin in several places and lift it up, and notice three things about it:

1. It is loosely attached to the flesh beneath it.

2. It stretches easily, but is elastic and springs back into place when you release it.

3. On the back of the hand it is as thin as a kid glove; on the arm and face it is as thick as shoe leather; and on the back of the neck it is as thick as sole leather.

The skin consists of two layers:

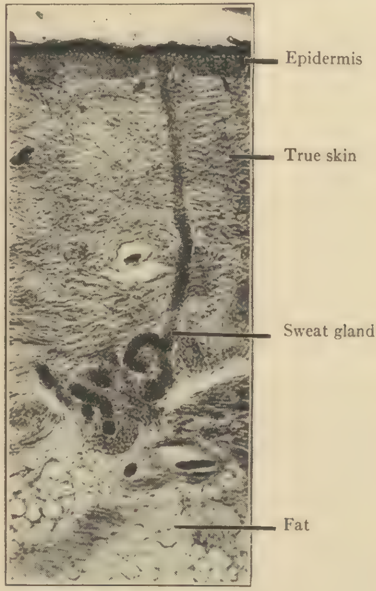
1. A very thin outer sheet called the *epidermis* (ĕp-ĭ-dûr′mĭs).

2. The thick main part called the *dermis*, or true skin.

Epidermis. — The word epidermis means *upon the skin*. The epidermis is like a sheet of thin paper pasted upon the true skin. It is as thin as tissue paper or cardboard over most of the body, but is as thick as wrapping paper on the palms and soles. It is the part which is raised when a blister forms on the skin, and which peels off when the skin heals after a sunburn. Take a fine

needle and thrust it under the skin as near the surface as possible. You can easily raise the epidermis in a loop without causing pain or bleeding, for it has no blood tubes or nerves.

The epidermis is composed of *epithelial* cells, matted together to form a sheet (p. 27). Wet a spot upon your skin and rub it hard until it is dry. You can rub loose cells from the surface, and form them into rolls. These are cells of the epidermis. You shed about a tablespoonful of cells from the epidermis every day, and can see them on your skin and clothes when you do not remove them by bathing. The whole epidermis is shed and a new one is formed about once a month.



SECTION OF THE SKIN
(Magnified 100 times.)

The epidermis protects the true skin and the flesh beneath it. A spot of skin from which it is removed is tender and sore, but it grows thick and forms a hard covering, called a *cal'lus*, upon a spot which is rubbed hard. If you work hard with your hands, you may in-

jure the growing epidermis at first and produce a blister; but after a few days of work, spots of callus will grow in order to protect the flesh from harm.

A tight shoe pressing on your foot may cause the epidermis to form a small callus, called a *corn*, which is tender and painful. You can prevent corns from forming by wearing shoes which fit the feet snugly without cramping them.

The epidermis is waterproof, and forms a covering which is like a sheet of rubber upon the skin. Very few substances which we usually handle can pass through it to enter the flesh. Poisons and disease germs may be handled with safety because they cannot pass through a healthy skin. But any wound or sore upon the skin is dangerous because disease may pass through it into the flesh, if it is not protected and dressed (p. 123). When a mosquito sucks blood, it thrusts its bill through the epidermis into a blood tube in the true skin. Some kinds of mosquitoes may carry the germs of malaria in their bodies and inject them into the flesh when they suck blood, and so they cause the bitten person to have malaria (p. 45).

Most liniments and other medicines which are placed upon the skin do not enter the body, for they cannot pass through the epidermis. The good which they do comes from the rubbing with which they are applied to the flesh. But a medicine may be given through the skin by means of a hypoder′mic syringe and a hollow needle thrust through the epidermis into the flesh.

Substances from within the body cannot pass through a healthy epidermis, but when the epidermis is wounded, the injured spot becomes wet with lymph which oozes from the flesh. When the skin is scalded, the young, growing cells of epidermis are injured, and the lymph oozes through them and lifts up the outer layer of epidermis and forms a blister.

Lymph, oozing from a small wound, may dry upon the surface and form a hard covering, called a *scab*, which protects the raw flesh. A scab is nature's dressing for a wound. It is an excellent dressing when the wound is clean and has no disease germs in it.

When a wound or a sore heals, new epidermis grows at the edge of the sore and spreads over the raw place, like grass over a bare spot of lawn. At the same time new flesh forms upon the sore spot and continues to grow until the epidermis covers it. If the epidermis does not grow rapidly, the flesh may grow up and form a soft mass called *proud flesh*. When a doctor treats a sore, he tries to make the epidermis grow as fast as possible. The epidermis stops the growth of flesh and completes the healing.

It will take the epidermis a long time to cover a raw spot when the sore is large. The healing may be hastened by skin grafting, which is done by cutting some growing epidermis from healthy skin and placing it on the sore. It will grow and form a new covering of epidermis. Skin grafts may be taken from another person, or from a lower animal, such as a frog.

The color of the skin is caused by two things:

1. The red blood in the skin showing through the epidermis, which is almost transparent, makes the skin pink. When you are faint, there is little blood in your skin and you are pale.

2. A layer of cells in the deep part of the epidermis contains a brown substance. Colored persons have a great deal of the coloring matter in their epidermis; blond people have little; albinos (ăl-bī′nōz) have none; and freckled persons have it in spots.

When the sun shines on the skin for some time, the cells take up more coloring matter and cause the skin to become brown, or *tanned*. The coloring matter is like a dark curtain which protects the skin from becoming sunburned. Blond persons do not form the coloring matter readily, and so they become sunburned more easily than those with dark skins.

The True Skin. — The dermis, or true skin, is like an animal's hide. It is composed of tough connective tissue fibers which are as strong as those in the skin of an animal. Leather is the dermis of a lower animal hardened by soaking in a tanning fluid.

The dermis contains three structures which have important uses in the body; namely, blood tubes, nerves, and glands.

Blood Tubes. — The skin contains many blood tubes. One of the principal uses of the blood tubes is to regulate the temperature of the body (p. 173). The tubes expand when the body is becoming too

warm, and they contract with the cold. Heat makes the skin red, and cold makes it pale.

Your feelings also affect the blood tubes of your skin. They expand and become full of blood when you blush, or are angry or excited. They contract and make you pale when you are frightened.

Nerves. — The skin contains more nerves of feeling than almost any other part of the body. They are most abundant in the tips of the fingers, and so we use the finger tips in feeling of objects.

The nerves of the skin end in peaked ridges, called *papil'lae*, which project into the epidermis. The papillae are numerous and large on the palms of the hands

Finger Prints

The surface of the skin of the palms and soles has raised lines which will print like type when they are inked.

and soles of the feet, and there they form lines in circles and spirals. Press your finger upon the ink of a stamping pad, and then upon a piece of white paper. The lines of your skin will form their print upon the paper. No two persons have the same pattern of finger prints,

and so a person may be recognized by means of his finger prints. Every soldier in the American army during the World War had his finger prints taken, for that was the surest way by which he could be recognized if he were killed.

Glands. — Glands in the skin form two useful substances; namely, perspiration, and an oil.

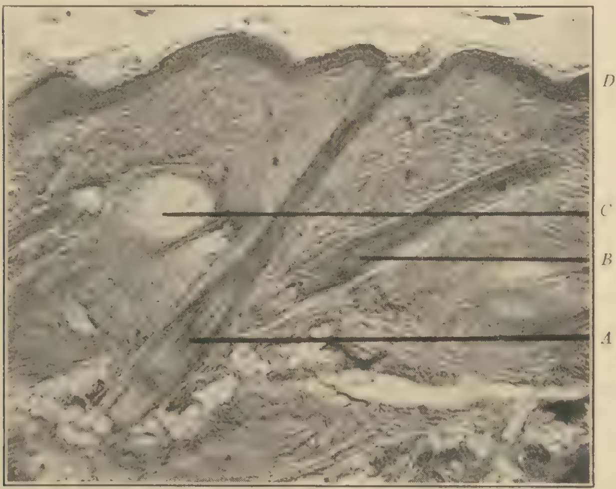
Perspiratory Glands. — A perspir'atory gland consists of a tube running from the surface down deep into the true skin. The tube is lined with plump cells which fill it so full that only a narrow space is left in its center. The cells are like those in the epidermis. The gland looks as if a pin had been thrust into the flesh and had carried with it a covering of epidermis which had clung to it.

Perspiration is made by the cells of the gland out of material which is brought to them by the blood. It flows out of the tubes and upon the surface of the skin. The pores of the skin are the openings of the perspiratory glands. Nothing enters the pores, and nothing except perspiration leaves them.

Oil Glands. — Special glands of the skin produce an oil which keeps the epidermis soft and smooth. The oil glands are like those which produce perspiration, except that they are short and branched, and they usually open beside a hair root.

The skins of many persons break out with fine red spots, called *prickly heat*, because, when they bathe, they use a soap which injures the epidermis. Taste the

soap which you use. If it burns your tongue, it will be likely to harm your skin by taking away its oil. A mild soap, like castile, is helpful to the skin, for it dissolves the dirt and loose oil without harming the epidermis.



A HAIR AND THE PARTS CONNECTED WITH IT

(Magnified 100 times.) *A*, hair root extending nearly all the way through the skin; *B*, a muscle which pulls the root upright; *C*, glands secreting an oil which softens the hair; *D*, epidermis.

Hair. — Hairs grow over almost the whole body except the palms of the hands and soles of the feet. You can easily find them, even on a baby, if you look sharp.

A hair is formed out of epidermis cells which lie in the bottom of a deep tube. As the cells grow, they become molded into a solid hair. A curly hair is flat like a ribbon, but a straight hair is round like a string. An oil

gland is connected with each hair in order to soften it and the skin. A slender band of involuntary muscles is also connected with each hair root. When your skin is cold, the muscles contract and lift the hair roots and cause a roughness of the skin, called *goose flesh.*

The only part of a hair which is alive is its lower part where the cells are soft. If a hair is pulled out, the soft growing cells at its root are left, and soon form a new one. A hair root lies too deep to be reached by medicines or liniments rubbed on the surface. You can keep your hair in good order by combing and brushing it, and by washing it and the scalp as you would the rest of your body.

Nails. — A nail is formed at its hinder part out of epidermis cells which grow under the flesh. As new cells grow, they push the whole nail forward.

The dirt which collects under the outer ends of the nails may contain disease germs. Keep your nails neatly trimmed even with the ends of your fingers. Clean the dirt from under their ends.

A hangnail is a sliver of epidermis which has been torn from the skin just behind the nail. Do not tear or bite it off, but cut it off close to the skin.

Complexion. — The appearance of the skin is called the *complexion*, and depends on three principal causes:

1. Blood.
2. The waste matters in the body.
3. The smoothness and clearness of the epidermis.

The skin shows a great deal about the state of the

health. A healthy person will nearly always have a good complexion. Plenty of good red blood flowing through the body gives the skin a pink color which is a sign of good health (p. 188). Waste matters, such as bile, circulating with the blood, stain the skin and give it a brown or yellow color. Pimples, sores, and scaly spots on the skin are usually signs that the body is in ill health.

There are two principal ways by which one may improve the complexion:

1. By treating the skin itself.

2. By caring for the health of the whole body.

It is important that you should keep your skin clean by washing and bathing it. You can help your skin by removing its dirt and waste matters; but you can seldom improve your complexion by rubbing things on the skin. Medicines, paints, and powders give the skin a make-believe look. When you use powder and paint on your skin, everybody can see that you have only an imitation complexion. Almost the only thing which you may need to rub on the skin is a little oil or cold cream to soften it when it is too dry or soothe it when it is irritated.

You can do a great deal for the skin by treating it from the inside of the body. Almost the only way by which you can improve the complexion is by improving the health of the whole body. If your body is healthy, your skin will take care of itself, and will be clear and soft and beautiful, like the skin and fur of a wild animal that is fat and sleek. The skin and complexion are

helped by such means as careful eating, exercise, fresh air, sunshine, work, play, and rest; and by getting rid of the waste matters of the body. Anything which helps to make you strong and healthy will help your skin and complexion.

Bathing. — The skin often becomes soiled and needs to be cleansed by bathing. Dirt on the skin consists of four principal substances:

1. Perspiration.
2. Dead epidermis.
3. Disease germs.
4. Dirt which comes from the soil, the air, and substances which touch the body.

Perspiration and dead cells of the epidermis decay and produce unpleasant odors. Germs of disease may cling to the hands and other parts of the body, and some kinds may grow among the dead cells of the epidermis. The body must be bathed for the sake of health as well as good looks.

You may know that your body needs a bath when you can see the dirt or when the skin has an unpleasant odor.

Your body is always giving off perspiration and shedding dead epidermis. You need a bath even when you do not touch dirty things. Bathe the whole body in hot soapsuds at least once a week, and more often than that if the air is dusty, or if you are doing dirty work.

You need to take great care in washing your hands, because they become soiled with all kinds of dirt, and

you often put them to your mouth and nose and handle food with them.

Be sure to wash your hands before you eat. Never handle food for yourself or others without first washing your hands.

Mucous Membrane. — The lungs, the stomach, and the intestine are lined with an inner skin, called *mucous membrane*, which is like the skin on the outside of the body. The outer skin extends into the nose and mouth and there becomes the mucous membrane which extends the whole length of the air tube and the food tube.

The mucous membrane consists of two layers which are like those of the outer skin:

1. An epidermis.
2. The true mucous membrane.

The epidermis of the mucous membrane, like that of the skin, protects the flesh; but unlike that of the outer skin, it lets some kinds of substances pass through it. The epidermis in the stomach and intestine takes up water and digested food and passes them into the blood tubes which lie beneath it.

The main part of the mucous membrane is like the dermis of the skin. It contains numerous glands which are like those of the skin. They produce a fluid, called *mucus*, which is like thin white of egg. Mucus is constantly being formed in order to protect the surface of the mucous membrane and to keep it wet and smooth. The watery substance which you blow from your nose

is mucus. It is almost like water while you are in good health, but when you have a cold, it is almost like jelly.

QUESTIONS

Describe the *epidermis;* the *dermis.*

What is a *callus?* a *blister?*

Why cannot substances rubbed upon the skin enter the flesh?

How are medicines given by means of a hypodermic syringe?

How does the epidermis complete the healing of a wound? What is *skin grafting?*

To what is the color of the skin due?

What are *finger prints?*

Describe a gland which forms *perspiration.*

Describe a *hair root.* What care should you give to your hair?

Describe a *finger nail.* Why should the nails be kept clean?

What is a *hangnail?*

To what is the complexion due? How can you improve it?

Give some reasons for bathing.

Why should you wash your hands before you eat?

What is the *mucous membrane?* Compare it with the skin.

For the Teacher. — The subject of the skin is taken up in some detail because of the erroneous impressions produced by popular articles on the care of the skin, and by fantastic advertisements of impossible skin foods, complexion clearers, beauty restorers, pore cleansers, and hair stimulants. The object of this chapter is to set forth briefly the simple truth about the structure and action of the various parts of the skin, and the nature of the common skin disorders, such as corns, blisters, and freckles.

Emphasize the need of washing the hands thoroughly before eating or handling food, in order to avoid transferring disease germs from the dirty hands to the food.

CHAPTER XVII

THE WASTES OF THE BODY

Intake and Outgo. — New substances enter the body every day, and other substances leave it. The daily intake of the body of a grown person of average size is about as follows:

Food (except water)	1	pound
Water	6	pounds
Oxygen	$1\frac{1}{2}$	pounds
Total intake	$8\frac{1}{2}$	

If all the substances which enter the body remained there, a person would gain eight and a half pounds weight every day. But the weight of a grown person remains about the same for months or years, and therefore the body must give off as much matter as it receives. The outgo of the body almost balances its intake.

Excretions. — Most of the substances which are given off from the body are those which have been oxidized in order to supply heat and power to the body. They are of no further use, but are waste substances which are thrown off. The waste substances of the body are called *excretions*.

The principal excretions of the body are:

1. Water.
2. Carbon dioxide.
3. Urea, and similar substances.
4. Minerals.

Organs of Excretion. — The body gets rid of waste matters by means of five *organs of excretion*, namely:

1. The lungs.
2. The skin.
3. The kidneys.
4. The liver.
5. The intestine.

The lungs give off most of the carbon dioxide which the body produces. They also give off about one fifth of the water which leaves the body. Some of the water in the breath may be seen like a little cloud on a cold day.

A Kidney Cut in Half

(Half its natural size.) A kidney is a gland which takes water, urea, and minerals from the blood.

The skin gives off water, urea, and minerals by means of the *perspiration*. The salty taste of perspiration comes from the minerals which are dissolved in it.

Most of the urea, minerals, and water which leave the body are given off by

a pair of organs, called *kidneys*, which lie in the back part of the body below the lungs. The kidneys are glands and consist of tubes which are like very long and folded perspiratory glands (p. 190). They produce a liquid, called *urine* (ū′rĭn), which consists of minerals, urea, and other waste matters, dissolved in water. Drinking an abundance of water helps the kidneys and skin to get rid of their excretions.

Excretion by the Intestine. — The intestine, or bowel, is the lower part of the food tube. It gives off two kinds of waste substances:

1. Those, such as bile, which are formed by the liver and other glands.

2. Those parts of food which are not digested or used by the body.

Waste matters are always being formed in the intestine, whether food is eaten or not; and getting rid of them at least once a day is one of the most important means of caring for health. They are harmful to the body when they are first formed, and when they lie in the intestine, changes occur which make them still more harmful. It takes one or two days for the waste matters and food to pass through the whole length of the food tube. If they lie in the intestine too long, they decay and putrefy as they would if they were lying in a warm, moist place outside of the body. Decaying matter in the intestine is a common cause of headache, stomach sickness, coated tongue, and bad breath.

Go to the toilet every morning after breakfast

whether you feel like it or not. If you do this, your intestine will learn to empty itself regularly every day. Training and exercising the bowel to empty itself is better than taking medicines for that purpose.

Effect of Food. — The food that is eaten has a great effect on the excretions of the intestine. If all the food which is eaten is digested and taken into the blood, none will be left in the intestine to decay and produce harmful wastes. If too much food is eaten, some will not be taken up by the blood, but will lie in the intestine until it decays and becomes poisonous. Eating too much is one of the most common causes of sickness. Not eating a food at all is better than taking medicine to get rid of it after it has been eaten.

Children often eat too much candy, and grown people often eat too much meat. The sugar which is not digested turns sour, and the meat decays in the intestine, just as it decays outside of the body. But both sugar and meat are good foods and will agree with a person who takes only as much as the body can use.

Need of Indigestible Food. — The intestine needs to be partly filled with solid matter which will push the waste matters forward and sweep them from the food tube. Every person needs to eat some food which leaves a large amount of solid waste that does not decay readily. Coarse vegetables, such as lettuce, celery, spinach, and cabbage, may be used. Whole-wheat bread also is valuable, for it contains a large amount of bran, or the papery husks of the wheat kernels. Al-

though these foods contain a great deal of indigestible wastes, yet they are wholesome and necessary, for they help the intestine to get rid of its waste matters.

Excretions of Nose and Throat. — The nose and throat are organs of excretion, for their mucous membrane forms mucus which we cough up from our air tubes or blow from the nose. Only a small amount of mucus is formed during health, but a large amount is often formed during sickness. When a person has a cold, or sore throat, or pneumonia, or other disease of the air tubes, the mucus is of great importance, for it may then contain germs of the disease.

Disease Germs in Excretions. — Excretions which have left the body may still be harmful or dangerous, for they may contain disease germs. When one has a disease which is catching, its germs are given off with two sets of excretions:

1. Those of the nose and throat.
2. Those of the intestine and kidneys.

A very small amount of an excretion may contain great numbers of disease germs. Not every person gives off disease germs with his excretions, but the germs may come from those who are only mildly sick, and from those who are almost well; and so we may suspect that the excretions of any person may contain disease germs. It is necessary to dispose of excretions in such a way that they cannot reach the body again, or its food, or drinking water.

Soiled hands and fingers often carry excretions and

disease germs from one person to another. A very small amount of an excretion with millions of disease germs in it may cling to the fingers and may reach milk or other food which is handled. When food has spread a disease, its germs have usually come from the soiled hands of those who handle the food.

Always wash your hands after going to the toilet.

Disposal of Excretions of the Nose and Throat. — Disease germs in the excretions of the nose and throat are often as numerous and dangerous as those in the excretions of the intestine and kidneys. Most persons have a fear of the excretions of the intestine and kidneys, and are careful to get rid of them in a way that is safe and clean; but people are often careless with the excretions of the nose and throat. They spread disease germs when they spit on floors and sidewalks; they blow disease germs into the air when they cough and sneeze; and they carry them around on handkerchiefs which are dirty. Mucus from the nose and throat is the principal cause of colds, sore throat, influenza, and pneumonia.

You can easily keep from spreading the excretions of the nose and throat if you will follow these rules:

1. Carry a handkerchief with you and use it. When it becomes soiled, get a clean one.

2. Hold your handkerchief in front of your nose and mouth when you cough or sneeze.

3. Blow your nose on your handkerchief. Keep your nose clean and free from mucus.

4. Spit in some place from which the mucus cannot escape. Do not spit on a floor or sidewalk.

5. Take care of the handkerchiefs, towels, dishes, bedclothes, and other things which are soiled by excretions of the nose and mouth. Wash them in boiling water in order to kill the disease germs which may be on them.

Sewage. — The waste water and slops from bathrooms, kitchens, laundries, and stables are called *sewage*. Nearly all sewage contains excretions from human beings; and it will contain disease germs when it contains excretions from a person who has an infectious disease. It often spreads diseases in two ways:

1. By flowing into drinking water.

2. By being carried to food or to the mouth and nose by flies or by other means. The safe disposal of sewage is one of the most important matters with which the people of cities and towns have to deal.

Sewage Disposal and Decay. — The final disposal of excretions, sewage, and other household wastes is nearly always done by means of the natural process of decay which is carried on by bacteria (p. 43). This process is closely connected with that of oxidation (p. 38). If oxygen cannot reach the decaying substances, gases are formed which have foul odors, and the process of decay is then called *putrefac'tion;* but if oxygen reaches every part of the decaying matter, the products of decay do not have very foul odors.

Substances which are buried in the ground usually

decay and become a part of the soil without being offensive. The soil contains oxygen, and also bacteria which cause the oxygen to unite with the buried substances. Most substances which decay in the soil are oxidized as completely as if acted upon by fire; and the only parts which are left are their minerals, or ashes. The disposal of excretions, and of sewage, garbage, and other household wastes, usually consists in causing them to decay and return to the soil in a harmless manner.

Disease germs which may be in excretions soon die when the excretions become decayed and oxidized. The proper disposal of sewage will not only remove its offensive substances, but it will also kill all disease germs which may be in the excretions.

Filter. — The soil also purifies sewage and other liquids by a process called *filtra'tion*. A substance which screens fine particles from a liquid is called a *filter*. The soil is a great filter. When sewage or other liquid passes through it, the sand and clay screen out the solid particles and hold them back, but allow the liquid parts to pass through. While the liquid is soaking through the ground, the bacteria in the soil oxidize and destroy both the solid particles which are held back, and also the liquid impurities which are dissolved in the water. The purification of sewage consists of a combination of the three processes of decay, oxidation, and filtration.

Disposal of Sewage in the Country. — The waste water of houses in country places is usually thrown upon the ground and quickly becomes purified. House slops

nearly always contain substances which may decay and produce foul odors. They also often contain human excretions and disease germs. When they are thrown upon the ground, they may soak into the soil and their impurities may be removed and destroyed by the processes of decay, oxidation, and filtration which take place in the soil. Only pure water usually passes deep into the earth. Underground water is nearly always pure unless a great deal of dirty water is poured upon the ground in one spot.

A common fault in the disposal of house slops is to allow slops and laundry water to flow upon one spot of ground until the soil is soaking wet and the useful bacteria of the soil are drowned from want of oxygen. The water may then pass through the soil unpurified, and may carry waste matters to the underground water; or it may form a muddy pool from which disease germs may be carried by flies and other vermin. A good way to get rid of house slops is to catch them in a pail or barrel, which is emptied in the back yard, first on one spot and then on another, so that no spot receives more than it can quickly purify.

Cesspool. — If a house has plumbing, and a supply of running water, the amount of sewage will be so large that it cannot be safely emptied upon the surface of the ground. A simple way to dispose of the sewage is to empty it into an underground tank called a *cesspool*. There its solid parts and other impurities slowly decay, and its liquid filters away through the soil. A

cesspool which is properly built, and which acts properly, will destroy the disease germs which may be in the sewage.

If a cesspool receives more sewage than the soil can purify, the sewage will reach the underground water and make it unfit for use. The underground water in villages is seldom pure if cesspools are used.

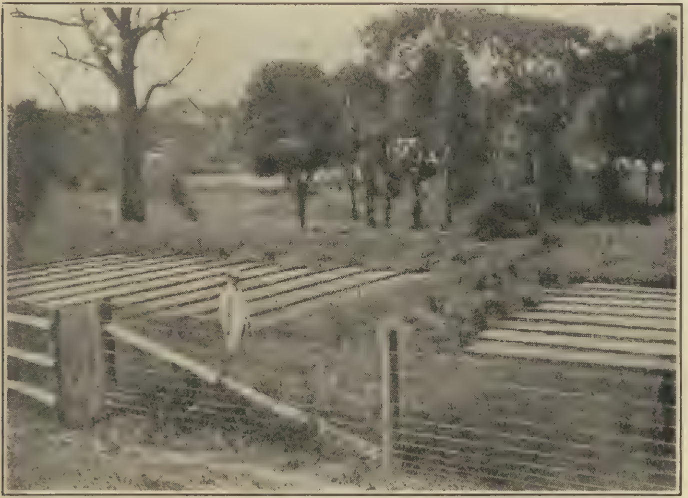
Sewage from a cesspool may flow along an underground rock or a layer of water-tight clay, and reach a well from which drinking water is taken. If a cesspool and a well must both be placed in the same yard, locate the well in a place from which both the surface of the ground and the underground rock slope away. Another danger from a cesspool is that flies may carry disease germs away from it, or mosquitoes may breed in it. A cesspool is not safe unless it is covered so closely that flies and mosquitoes cannot enter it.

Sewers. — Cities and large villages make more sewage than cesspools can safely receive. In these places the sewage is taken away by means of underground pipes, called *sewers*, which are built at public expense. The sewage from a small city would make a good-sized stream, and that from a large city, like New York, would make a river. It is difficult to get rid of this great quantity of sewage.

Many cities, such as New York, Albany, and Troy, empty their sewage into the nearest body of water. But the sewage makes the water impure, and spoils it for the people of other cities who wish to use the river

water for drinking or washing. The people of the city of Albany take their drinking water from the Hudson River, and have been put to great expense in removing the sewage which is poured into the river from the city of Troy.

Sewage Disposal Plant. — One of the most necessary public works for a city or large village is a sewage disposal plant which purifies the sewage. A sewage disposal plant which acts properly will destroy the disease germs which may be in the sewage.

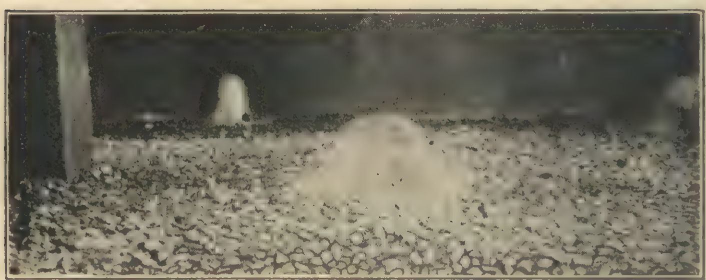


Sand Filter Beds of a Sewage Disposal Plant of a Small Village

Troughs spread the sewage evenly over the surface.

One of the best forms of sewage disposal is to collect all the sewage into a large water-tight cesspool, called a

septic tank, where its solid parts decay and become liquefied as in a small cesspool. The liquid which overflows from the tank is then emptied on plots of sand, first on one, and then on another, so that each plot is used



SPRINKLING SEWAGE UPON A BED OF BROKEN STONE

Mixing sewage with oxygen destroys much of the bad odor.

only once a day. The soil of the sand plots acts like a filter and destroys the impurities in the sewage, just as the soil does when a basin of slops is thrown on the ground in a back yard. This method of getting rid of sewage is almost like nature's own way of purifying dirty water. A sewage disposal plant that is run properly is no more unpleasant to sight or smell than a stable or barnyard.

In some sewage disposal plants the impure water which flows from a septic tank is sprayed upon large beds of broken stone before it flows upon the soil. The stone bed causes the sewage to be mixed with oxygen, and its impurities to be oxidized and destroyed.

Gas Trap. — The pipes which carry waste water away from houses are laid sloping so that the water will

quickly run out of them. The waste pipes are nearly always empty, and are likely to let foul-smelling gases into the room, unless they have arrangements, called *traps*, to keep the gases out.

In a common form of trap, the upright part of the waste pipe under a tub or basin is bent in the form of a deep loop. When the tub or basin is emptied, the loop of the pipe remains full of water, and prevents gases from escaping. The plumbing of a house will be unsafe unless there is a trap in each waste pipe under the sinks, bathtubs, and basins.

GAS TRAP

When water runs out of the basin, the loop remains full and prevents gases from passing up the pipe and into the room.

Garbage. — The solid waste matter from a kitchen is called *garbage.* It consists of such things as scraps of food, potato peelings, meat rinds, bones, dirty tin cans, and ashes. These are often thrown in a pile behind an outbuilding. Slops are often thrown over them, making a foul mass in which disease germs live. House flies often flit back and forth between the pile and the

kitchen, and carry filth and disease germs to food. A garbage heap is dangerous to health.

You can easily get rid of garbage without throwing it into heaps. Feed scraps of food to chickens or pigs, or burn them. Burn or bury everything else that will decay.

In many cities, the garbage is collected at public expense and sorted. Much of it is put to use so as to help pay the cost of its disposal. For example, grease and fat are preserved for soap making, and wood and paper are burned under steam boilers.

QUESTIONS

What quantity of substances enters and leaves the body every day?

What is an *excretion?* Name the principal excretions; the principal organs of excretion.

What substances are excreted by the lungs? by the skin? by the kidneys? by the liver? by the intestine?

Why is some indigestible food needed in the intestine?

Why are the excretions of the nose and throat dangerous? How can you dispose of those excretions in a safe way?

What is *sewage?*

What are the dangers from sewage?

What is *putrefaction?*

How does the soil destroy sewage and other waste substances?

What is *filtration?*

Describe the natural process of purifying slops and sewage when they are thrown upon the ground.

What is a *cesspool?*

What are the dangers from a cesspool?

What is a *septic tank?*

Describe a simple sewage disposal plant.

Describe a gas trap in house plumbing.

Of what does garbage consist?

How can garbage be disposed of in a safe way?

For the Teacher. — This chapter gives a bird's-eye review of the subject of excretions from the time of their production in the body to their final disposal in sewage and household wastes. The following topics need to be specially emphasized because they are not generally discussed:

Disease germs in the excretions and the danger from them after they have left the body.

Methods of disposal of the excretions of the nose and mouth.

Safe methods of the disposal of the excretions of the intestine and the kidneys.

Sewage disposal in the soil by the natural processes of decay, oxidation, and filtration.

It would be desirable to discuss the proper construction and care of outdoor toilets and cesspools. Lay stress on the necessity of making them fly-tight, so that flies and other vermin cannot enter them. Also call attention to the possibility of unpurified water from them reaching a water supply which is used for drinking.

Call the attention of the class to the sewage disposal system of the school and mention its good points as well as its defects. Try to induce the school authorities to maintain the toilets and other devices in a model sanitary state, as an example for the people of the community.

CHAPTER XVIII

WATER SUPPLY

Quantity of Water Needed Daily. — Each grown person needs about three quarts of water to replace that which passes off from the body each day. One or two gallons of water will be needed for preparing and cooking the food, and for washing dishes; and at least another gallon will be required in washing and bathing the body. Each person requires at least three gallons, or one large pailful, of water each day.

In many families each person uses at least five gallons a day in bathing, laundering, and house cleaning. If the house has a bathroom, this quantity will be much more than doubled. A great deal of water is also used in stables and in the care of animals. A city has to supply at least thirty gallons a day for each person. London supplies thirty-five gallons a day for each inhabitant. New York supplies two or three hundred gallons, but much of it is wasted.

Source of Water Supplies. — The simplest way to get a supply of water is to take it from a natural spring, or stream, or lake. Another way is to dig or drive a well, so as to reach the underground water. Another

way is to catch rain water from a roof and store it in a cistern.

Those who live in cities and large towns draw water from pipes which connect with the public waterworks, but the water usually comes from streams or lakes, or underground sources.

There are differences in the taste and appearance of water from various places. The differences are due to substances which are contained in the water.

What Is in Water. — Water always has substances dissolved in it. The purest water is rain water, but that has air in it. If we could get water with nothing dissolved in it, we should not like it, for the pleasant taste of good water comes largely from the air which is dissolved in it.

Boil some water in a clean kettle for five minutes. It will taste flat and unpleasant, for most of its air has passed off with the steam. Now stir or shake it to a foam so that it will become mixed with air. It will now taste like fresh water again.

Underground water, and the water in springs, streams, and lakes, come from rain or snow. As the water soaks through the ground, it dissolves lime, salt, and other minerals from the soil. Nearly all underground water has a little lime and salt dissolved in it.

Let a drop of clear water dry on a clean glass. It will leave a whitish spot of minerals which had been dissolved in the water. You can often see these spots of minerals on a window after it has been washed.

Soft and Hard Water. — The minerals in water are often too small in quantity to be noticed. Such water is called *soft* water.

In some places the water has so much lime dissolved in it that the minerals form a scum when soap is added to the water. Such water is called *hard* water. The minerals in hard water do not make it unfit for drinking. Hard water is sometimes not good for cooking, for some foods, such as peas and beans, do not easily become soft when they are boiled in it.

Mineral Water. — Water in which many mineral substances are dissolved is called *mineral* water. Some mineral waters are bubbling full of carbon dioxide which gives them a pleasant taste and a sparkling appearance. Some waters contain sulphur, or iron, or potash, or other minerals which are used as medicines. The good effects of drinking mineral water come from the water itself as much as from the minerals which are dissolved in it, for many persons who usually drink too little water will drink large quantities of mineral water.

Impurities in Water. — Much of the water which is used in houses contains either pieces of wood and leaves, or bits of iron rust, or particles of clay and mud. A little of them will do no harm, but if the water is muddy, or colored, or tastes bad, it will be likely to harm those who drink it.

Almost the only dangerous impurities in water are disease germs. The principal reason why dirty water

is harmful is because disease germs are often found in the dirt. But disease germs may be in water which is clear and sparkling, and pleasant to the taste.

How Disease Germs Get into Water. — Water will not produce a disease unless it contains living germs of the disease. Disease germs are not produced by dead leaves, or grass, or sticks, or mud. They are formed only in the bodies of sick persons or animals. If they are in water, it is because they came there with sewage containing the excretions from a sick person or a sick animal. Keeping water pure means keeping it free from sewage and from dirty water from houses and barnyards. Nearly all the dangerous impurities in water come from human beings.

Diseases Caused by Impure Water. — The principal kinds of disease germs which are found in impure water are those which cause stomach aches, typhoid fever, and other diseases of the intestine. Most rivers which flow past farms or towns contain sewage, and many of the people who drink the water of the rivers are made sick, unless the water is purified before it is used. Hundreds of people die each year in the United States from typhoid fever which is caught from drinking water containing sewage. Nearly all of these deaths are due to carelessness and neglect, and could easily be prevented by proper care of sewage. In one small city over a thousand persons caught typhoid fever because the slops from a person sick with typhoid fever were thrown upon a frozen hillside, and later

were washed into the river which supplied the city with drinking water.

Pure Drinking Water in the Country. — People in the country usually get their drinking water from wells which are sunk into the underground water. This

An Unsafe Well

It is open at the top, and barnyard drainage can flow into it through its lining.

water is nearly always pure, unless some ignorant or careless person allows excretions, or slops, or barnyard drainage to run into the well, or into the underground water which feeds it.

Many wells are unfit for use because they are placed over underground streams of dirty water flowing from

cesspools, or wet barnyards, or from dumping places for slops and excretions. The place for a well is on the highest part of a yard, so that all dirty water, both from the surface and from underground, will flow away from it.

If a spring or well is open at the top, or has sides of brick or stone, dirty surface water, worms, and other impurities may fall into it, or may drop through cracks in the bricks or stones. An old-fashioned open well is not safe, even if the underground water is pure when it flows into the well. A well made by driving a small iron pipe into the ground is safe if the underground water is pure, for no dirt can fall down it.

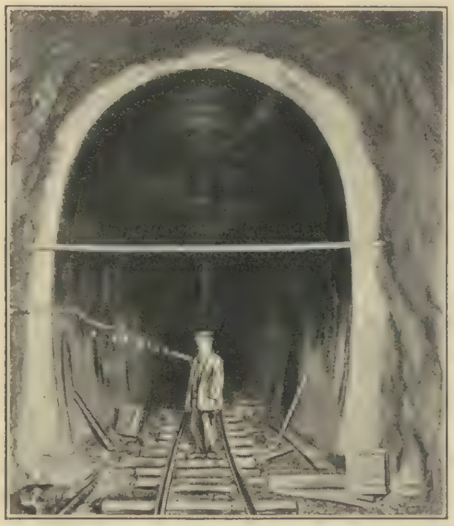
A DRIVEN WELL

Nothing can fall into it.

Pure Drinking Water in Cities. — The people of cities have their water brought to their houses through aqueducts and pipes which are fed from public water-works. If the water in the works is pure, the water in the houses will also be pure, for nothing can get into the pipes except that which comes from the water-works.

Many cities take their water from rivers or lakes which contain sewage. If they do not purify their

water, they have more typhoid fever than those which do purify it, or which take their water from pure sources. In the city of Albany, during the ten years following the year 1900, there was only one fourth as much typhoid fever as there was during the ten years before 1900, because since 1900 the water has been purified before being sent through the city.



In the Catskill Aqueduct

This shows one part under construction as a tunnel. The completed aqueduct supplies the city of New York with pure water.

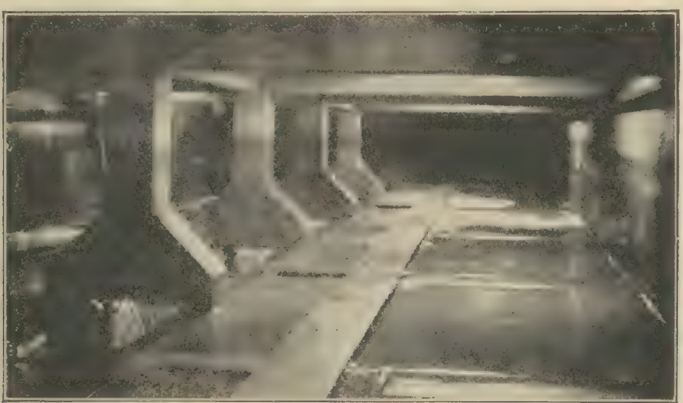
Reservoirs. — One way of purifying drinking water is to store it in a reservoir for a few days. The dirt and mud, and most of the bacteria, will sink to the bottom, and the sunlight will kill many of the bacteria. A reservoir is a great help in purifying drinking water, but it alone will not make impure water entirely safe.

Filtration. — One of the easiest and best ways of purifying water is to pass it through a large bed of sand, called a *filter*, which strains out dirt and bacteria. The soil is a great filter (p. 204). If a filter is very

large, and the water passes through it slowly, it will take out very nearly all the dirt and disease germs that

THE WATER FILTRATION PLANT OF ALBANY, N. Y.

may be in the water. Albany, Philadelphia, and many other large cities which have to take their water from



ONE OF THE ALBANY FILTER TANKS, WITH THE WATER DRAWN OFF

It contains about three feet of sand, above which the water is allowed to lie about three feet deep, and to pass slowly down through the sand.

impure rivers, pass the water through great filters, in order to purify it.

If a filter is small, or if water is run rapidly through it, the flow of water will wash bacteria and disease germs through it as if it were a sieve. For this reason the small filters sold for use in kitchens will not purify the water.

Purifying Water by Boiling. — If drinking water is not pure, we can make it safe for use by boiling it, for a boiling heat will kill the disease germs. Many persons who fear to drink plain water drink tea or coffee. The tea or coffee which is added to the water does not make the water safe, but the heat of boiling the drink kills the disease germs in the water. The Chinese are able to drink dirty river water with safety, because they boil the water which they drink, and cook all their food before eating it.

Water which has been boiled for some minutes tastes bad, because the boiling drives the air from it (p. 213). If the water is taken from the fire as soon as it begins to boil, the disease germs which may be in it will be killed, but the water will not lose much of its air, and its taste will not be changed.

Purification by Chlorine. — Adding liquid chlorine (klō′rĭn) to water is the usual method of treating suspected water in order to make it safe for drinking. The chlorine acts by killing the disease germs and other bacteria which may be in the water. Many villages and cities which take their water from streams and lakes treat the water with chlorine in order to be sure that the disease germs in it are killed.

Ice.—Ice taken or made from impure water will contain disease germs if the water contained germs before it froze. Those who work or skate on the ice may leave disease germs on it, or the ice may be soiled by the dirty hands or dirty clothes of those who handle it. Cold will not kill the germs, and they will grow as soon as the ice melts. The purity of the ice which is put into food and water is of as much importance as the purity of the food and the water themselves.

Washing with Impure Water. — Impure water which is used in bathing the body or in washing dishes may be the cause of spreading diseases. Milk cans which have been washed in impure water have often been the cause of typhoid fever in those who have taken milk from the cans. It is almost as dangerous to use impure water for washing as for drinking.

Examining Water. — The purity of a water supply may be determined in three ways:

1. By a sanitary survey.
2. By a chemical analysis.
3. By a bacteriological examination.

Sanitary Survey. — Most water in wells, springs, streams, and lakes is naturally pure and wholesome, and will remain so unless excretions from human beings or animals reach it. The sources of possible impurities may be easily found by means of a *sanitary survey* of the source and the land around it. When a sanitary survey is made, the following points are to be observed:

1. The source itself, — a well, cistern, stream, lake, etc. If it is a well, notice its construction, state of repair, and the means for keeping dirt and waste water from falling into it.

2. The soil around the source. Is it high or low? sandy or clayey? grassy or bare? level or sloping? inhabited or deserted?

3. Possible sources of pollution by excretions. Notice kitchen waste, toilets, cesspools, drains, barnyards, and cultivated fields near the water.

Chemical Analysis. — A chemical analysis will show the kinds and amounts of substances which are dissolved in a water sample. Minerals are dissolved in nearly every water, and their kind and amount in any place naturally continue nearly the same from time to time. Almost the only things which are likely to increase the amount of minerals are sewage and barnyard drainage, especially the excretions of men and animals. One of the most common of the minerals in excretions is *sodium chloride* (sō′dĭ-um klō′rīd), or common salt. If the amount of salt in water from a certain source is greater than that which is natural for that place, the extra amount has probably come from sewage.

Bacteriological Examination. — Most water naturally contains a few living bacteria of decay which come from the air and soil. Only a few hundred are found in each cubic centimeter of clear, wholesome water, but the presence of several thousand shows that decaying matter is in the water.

Water is also examined for living bacteria of the intestine, or *co'lon bacilli* (bȧ-sĭl'ī). Their presence shows that fresh excretions from the intestines of persons or warm-blooded animals are reaching the water, and that living disease germs may also be in the water.

Colon bacilli in water may come from three sources:

1. Animals or birds.
2. Surface drainage from roads or cultivated fields.
3. Sewage or barnyard drainage.

A sanitary survey will show which of these sources is producing the colon bacilli.

An increase in the amount of salt, if colon bacilli are absent, shows that sewage is probably entering the water, but that its impurities are fully oxidized to ashes or mineral matter. Such water may be pure and wholesome, but it may become unwholesome if the amount of sewage is increased.

An increase of salt in water, if living colon bacilli are present, shows that fresh, unpurified excretions are reaching the water, and that the water may contain living disease germs.

Public Drinking Cups. — Drinking cups are often placed in schools, in railroad trains and stations, and in public buildings, to be used by any one who wants a drink. Every person who takes the cup between his lips leaves mucus, epithelial cells, and bacteria from the mouth upon the rim of the cup, and the next person who drinks from the cup takes some of them

into his mouth, and leaves more from his own mouth upon the cup. Some one who has a cold, or a sore throat, or a worse disease, is almost sure to use the cup and to leave disease germs upon it. Tuberculosis and diphtheria are two diseases which are likely to be spread by the use of the cups. Public drinking cups are so dangerous that some states have laws that none shall be placed in any public place in those states.

PAPER DRINKING CUPS

Paper drinking cups are often placed in public drinking fountains, to be thrown away as soon as they have been used. They are for sale at drug stores and stationery stores. They are cheap and may easily be carried. Take some with you and use them when you go away from home, or when you start on a journey.

A SAFE DRINKING FOUNTAIN
The nozzle is at the side where no one can touch it.

If you must use a public drinking cup, do not take the rim between your lips, but touch both lips to the water inside the rim. Thus your lips will touch nothing except the water of the cup.

Bubbling Drinking Fountains. — Schools and other public places often have drinking fountains in which the water bubbles up in a stream. Some of these fountains have two defects:

1. A person drinking can touch his lips or mouth to the fixtures.

2. Excretions from the mouth may fall on the fixtures.

A safe form of drinking fountain is one in which a jet of water spouts sidewise in a stream from a fixture which is covered with a shield. A person drinks from the outer part of the stream and cannot drop excretions upon the fixture.

QUESTIONS

How much water does a man need to take into his body each day?

About how much water will each person in a family use in a day?

Of what use is air in water?

What is meant by hard water? What are mineral waters?

Of what do the common impurities in water consist?

What are the most dangerous impurities in water?

How do disease germs get into water?

What diseases are often caused by impure water?

Why is water from an open well not so safe as water taken from a driven well?

How does storing water in a reservoir help to purify it?

What is a *filter?*

How does boiling purify impure water?

How may ice be a means of spreading diseases?

How can you tell whether or not a water supply is pure?

For what conditions would you look if you should make a sanitary survey of a source of water?

When a chemical analysis of water is made, what substance indicates that sewage has entered the water?

What do *colon bacilli* in water indicate?

What harm is often done by the use of public drinking cups? Give some reasons for using paper drinking cups.

Describe a safe form of drinking fountain for schools.

How can you drink from a public cup with the least danger?

For the Teacher. — The standards for a household water supply are:

1. The water shall be clean and clear.
2. It shall not be excessively "hard."
3. It shall be free from disease germs.

From the standpoint of hygiene, disease germs are the most important impurities in water. Their source is human excretions and household sewage. The principal diseases which are spread by drinking water are those which affect the intestine.

The examination of water supplies is conducted along three lines:

1. A sanitary survey of the source of the supply and the country around it is made in order to see if there are any houses, toilets, cesspools, sewers, or barnyards from which excretions could come.

2. A bacteriological examination of a sample of the water is made in order to determine the presence of colon bacilli.

3. A chemical examination of a sample of the water is made in order to determine the quantity of the special mineral matters of human excretions and sewage. Most water contains some of these minerals which are derived from such sources as fertilizers thrown upon the soil, but an excess of these peculiar minerals shows that sewage is reaching the water.

When a village or city grows so much that wells on its outskirts become polluted with sewage, repeated analysis of the water will show the progress of the pollution. The water will first show increasing amounts of minerals, and later when the limit of the purifying ability of the soil is reached, colon bacilli will appear, and the water will be dangerous for household use.

Demonstrate the process of filtration by filling a lamp chimney two thirds full of garden soil, standing it in a pan, and adding muddy water until the chimney is full. The water which oozes from the bottom of the chimney will be nearly clear. In order to purify water efficiently, the water must pass through the filter slowly, as it does through the soil after a rain.

Be sure to make a practical application of this chapter to the water supplies of your school, the homes of the pupils, and the public supply of the village or city. Have the pupils visit the source of the supplies and notice the possible sources from which pollution might reach the water. If possible, obtain an analysis from the health officer, and explain it to the pupils.

CHAPTER XIX

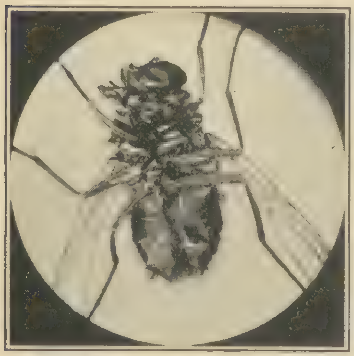
VERMIN

How Insects Cause Diseases. — Men used to think that flies, mosquitoes, and other insects did not harm a person beyond causing a tickling and itching when they bit the skin. It is now known that many of them are disease carriers, and are dangerous to health and life. Nearly all insects that bite the body may carry diseases from a sick person or animal to the next person or animal whom they bite. The most common and most dangerous insects that affect the health are flies, mosquitoes, cockroaches, lice, bedbugs, and fleas. Insects and other small animals which are troublesome to man, or are harmful to health, are called *vermin*.

Bee Stings. — The stings of bees and wasps cause swellings which are painful for a short time, but they are not the cause of any disease, for bees and wasps do not go from person to person as flies and mosquitoes do. Most insects which are harmful bite in order to get food, but bees and wasps sting only to protect themselves from harm. If one buzzes around your head, it will not touch you if you keep still and do not annoy it.

A bee stings by means of a hollow spear which it thrusts into the skin from the hinder part of its body. The spear itself is too small to hurt, but the bee uses it to force a bit of poison into the skin. This poison is what causes the swelling and the pain of the sting. You can relieve the pain somewhat by pinching the skin so as to squeeze the poison out of the flesh. Cold water, or a little ammonia rubbed on the spot, will also help to relieve the pain.

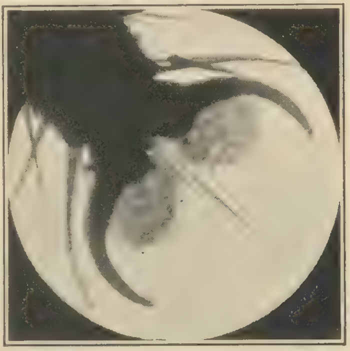
Danger from House Flies. — A house fly cannot bite, or sting, or scratch, and yet it is dangerous because of the places which it visits in search of food. It lights upon garbage heaps and excretions, and in dirty stables, where its legs and body become soiled with filth and disease germs. It then flits into houses and crawls upon food and over the mouths and eyes of helpless babies, dropping disease germs wherever it goes. The blue flies, which may often be seen swarming over decaying meat, may also be the carriers of disease germs.



Underside of a House Fly
(Magnified 5 times.) A fly is bristly and hairy, and dirty.

A fly's body and legs are covered with stiff hairs, which catch dirt and filth. Under a microscope the fly looks like a bristly pig that has been wallowing in

the dirt. It tries to keep itself clean, for it often rubs its feet together, and brushes its front legs over its head, as a cat does. But it is usually covered with bacteria which it gets from the dirty places where it alights. Shaking a fly in a bottle of water will often wash more than a million bacteria from its body. A fly which falls into a milk pitcher usually leaves thousands of bacteria and disease germs in the milk.



A Fly's Foot

(Magnified 200 times.) It is rougher than the foot of an elephant, and it leaves tracks of dirt and bacteria wherever the fly crawls.

The most common forms of sickness that are spread by house flies are typhoid fever and other intestinal diseases. Many of the stomach diseases of babies are caused by disease germs which flies have left in the children's milk or in their mouths. Sore eyes of a baby are often caused by flies crawling over the baby's face. Tuberculosis may be spread by flies.

Protection against Flies. — A house fly will not carry disease germs if it cannot go where it can pick them up. Keep flies out of all sick rooms. Cover all excretions and sewage fly-tight. Clean up the garbage heaps in the back yard, and either burn or bury all decaying matter. If everybody did these things, flies would

not carry diseases, for they could not get the germs on their bodies.

Another method of protection against flies is to cover windows and doors with screens and fly netting in order to keep all flies out of the house and away from food. A swarm of flies in a kitchen or dining room is far more dangerous than a swarm of bees. In our war with Spain the number of soldiers who were killed

LIFE HISTORY OF A HOUSE FLY

A fly is first an egg, then a maggot, then a pupa, and finally a winged fly.

by house flies was five times the number of those killed by bullets, for the flies spread typhoid fever through the camps.

Flies find their food by means of their sense of smell. They prefer substances which have an unpleasant odor of decay, and they flock to dirty garbage cans and to kitchens which have a strong odor of filth. Cleanliness of kitchens and dining rooms is a great help in keeping flies away from food.

The Life of a Fly. — A fly lives only half of its life as a winged creature. During the first half of its life it looks like a worm, and is called a *maggot*. Every maggot in a manure pile, or garbage heap, or mass of decaying filth, is a young fly.

Maggots hatch from eggs which are laid by winged flies in stable cleanings, wet garbage, decaying meat, and wet filth of all kinds. The "flyblows" which are often seen on decaying meats and garbage are the eggs of flies. The maggots reach their growth in about a week. Their skins then harden into brown shells, called *pupa* cases, which look like fat grains of wheat. The young flies lie quietly in the cases for a few days and then come out as full-grown flies with wings.

MAGGOTS IN A MANURE PILE

(Natural size.) Every maggot is a young fly.

Getting Rid of Flies. — If there were no manure piles, or garbage heaps, or other masses of decaying filth, there would be no places in which flies could hatch or grow. Remove all manure piles and garbage heaps at least once every week. Keep all stables and barnyards clean and dry. Doing these things throughout a town will rid the place of flies.

The time to begin to fight flies is early in the spring. Only a few flies live through the winter, and all that are seen in the following summer are descended from them. Each fly lays over a hundred eggs, and the new brood is ready to lay eggs within two or three weeks. Every maggot or fly that is killed in the spring and early summer means thousands less flies later in the season.

Mosquitoes and Diseases. — Certain kinds of mosquitoes are the means of spreading malaria and yellow fever, and for this reason they have been the cause of some of the worst epidemics that the world has ever seen. The discovery that mosquitoes will carry diseases was made about the year 1900. Before that time it was difficult for those living in Panama and Havana to avoid catching malaria and yellow fever. These diseases have almost disappeared from those places since the time when the United States government showed the inhabitants how to destroy all mosquitoes.

Malaria is caused by living germs which grow in the blood. A mosquito that sucks blood from some one who has malaria takes the germs into its body, and afterward gives them to persons whom it bites. The germs of malaria will live in only a few kinds of mosquitoes, but these kinds are scattered over a large part of the earth, and may grow where other kinds grow.

One way of telling a malarial mosquito is by its position when it alights, for it seems to stand on its head with the hinder part of its body pointing away from the surface on which it stands. It has spots on its wings.

Yellow fever is caught in the same way that malaria is caught, but the mosquito which carries the germs of yellow fever usually grows only in warm countries, for freezing kills it.

Life History of a Mosquito. — Mosquitoes hatch from eggs which are laid by the full-grown insects in any bit of quiet water that they can find. The eggs are black, and look like flakes of soot floating on the water.

MOSQUITO, EGGS, AND WIGGLER

(Magnified 5 times.) A mosquito lays eggs on water; wigglers hatch from the eggs and live in the water, and finally turn into winged mosquitoes.

Young mosquitoes are the tiny creatures called *wigglers*, that may often be seen in rain barrels resting at the surface of the water, and wiggling themselves down into the water when they are disturbed. They are found in all kinds of stagnant water, such as marshes and mud puddles, and pails and cans of dirty water. Cesspools are often full of them, and even vases of flowers may contain them. About two weeks after they hatch, the wigglers change to winged mosquitoes which fly away, leaving their empty skins floating on the water.

How to Get Rid of Mosquitoes. — We can get rid of mosquitoes by destroying them in their breeding places. If mosquitoes can find no stagnant water in which to lay their eggs, no young ones can grow. Very many of the mosquitoes around houses are hatched in pails, tin cans, and rain barrels. If these vessels of water are emptied once a week, young mosquitoes will not have time to become full grown in them.

WIGGLERS CLINGING TO THE SURFACE OF WATER

(Natural size.) The wigglers must come to the surface in order to breathe.

Wigglers must come to the surface of the water to breathe. If kerosene or other oil is poured on the water, the wigglers cannot get air, and they soon drown. A teaspoonful of kerosene poured into a barrel of rain water will kill all the wigglers in it, and will not harm the water for washing purposes.

WIGGLERS IN A DITCH

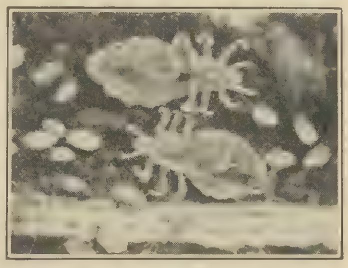
Hundreds could be scooped up with every dip of a teacup.

The principal breeding places for mosquitoes are swamps and marshes that are full of stagnant pools.

We may dry up the pools by digging ditches which will drain off the water and leave the surface dry. No mosquitoes can then grow except in the ditches, and there they will be eaten by fish, or carried away by the current of water. Many of the marshes near the city of New York have been freed from mosquitoes by being drained.

Cockroaches. — Cockroaches are long, brownish insects that live in cracks of kitchen floors, and among the water pipes, and in dark, damp places in houses. They do not bite persons, but they live upon garbage and filth, and may be the means of carrying disease germs to food as they crawl over it. They may be killed by means of insect powder. Cockroaches are not likely to appear, if floors of kitchens and bathrooms are tight, and the plumbing of the house is open and clean.

Lice. — One of the most dangerous of insects is the louse, for it is the cause of typhus fever. It spreads the disease by sucking the blood of those who have typhus fever and carrying the disease germs to the next persons whom it bites. There are two common forms of lice, — the head louse, and the body louse. Both hatch from eggs, called *nits*.



BODY LICE AND THEIR EGGS

(Magnified 10 times.) They carry typhus fever. Head lice are also dangerous to health.

Body lice live on the underclothes, and lay their eggs in the seams. Keeping the body clean and boiling the clothes will rid the body of the lice. The eggs of head lice are fastened to the hairs close to the skin. If the eggs are found at a distance from the skin, they have been laid for so long a time that the growth of the hair has carried them away from the skin.

Washing the hair in strong soapsuds, to every pint of which a tablespoonful of kerosene has been added, will kill the lice, but the eggs may remain alive and hatch a new brood. After using the kerosene, soak the hair in weak vinegar in order to dissolve the glue which binds the eggs to the hair. The eggs may then be washed away, and the head entirely freed from the lice.

Bedbugs. — Bedbugs are brown, flat insects about an eighth of an inch in length. They live by sucking a person's blood, and may carry a disease, such as tuberculosis, from one person to another. They have no wings, and will not be found in a house unless some one brings them there. We may get rid of them by cleanliness and by searching them out and destroying them.

Fleas. — Fleas are small, brown insects that move by long jumps. They are often found on dogs, cats, rats, and other lower animals. They sometimes jump upon the bodies of persons. They live by sucking blood, and may carry disease germs from one person or animal to another.

The plague is a disease of rats as well as of mankind. It is usually spread by means of the bites of fleas which have taken the germs from diseased rats. This disease killed millions of people in Europe a few hundred years ago, and is still found in some parts of the world. The principal means of preventing the spread of the disease in a town is by killing all the rats there.

Rats and Mice. — Rats and mice may become sick with several diseases which persons may take from them. Besides the plague, they may also have epidemic jaundice (jän′dĭs), and may spread the diseases to man. Both rats and mice may also carry disease germs in dirt on their bodies, and may spread them to food and drinking water.

Some of the means of getting rid of rats and mice are:

1. Cleaning up cellars and tumble-down buildings, and destroying places in which the animals may hide.

2. Making cellars and foundations of houses so tight that the animals cannot enter the buildings.

3. Removing or burning heaps of garbage and rubbish. A village dump heap is often full of rats, and is usually a menace to health.

Stray Cats and Dogs. — A dog or a cat is called mad when it has the disease called *rabies* (rā′bĭ-ēz), or *hydrophobia* (hī-drō-fō′bĭ-ȧ). Rabies is caused by germs which grow in the brains and also in the mouths of the sick animals. Most of the animals and persons that have rabies catch it from the bites of

homeless dogs and cats on the streets. A public dog catcher, to catch all stray dogs and cats, is an important and useful officer.

If a person is bitten by a dog or cat, do not kill the animal, but shut it up to see if it has rabies. If it has the disease, it will die within a few days. If it lives, it has never had rabies, and there is no danger that its bite will give any one rabies.

A person bitten by a rabid animal can escape having the disease by taking the kind of vaccination which is called the Pasteur (pȧs-tûr′) treatment. You can get information about the treatment from the boards of health of the states and large cities.

Sick Pets. — Pet animals sometimes have the same kinds of sickness that people have, and persons may catch the diseases by handling them. If your cat, or dog, or other pet animal is sick, do not handle it or leave it in the house, but give it a good bed in the basement or barn, and let a careful grown person take care of it.

QUESTIONS

What are *vermin?* Name some of the common vermin.
How do house flies spread diseases?
What diseases are often spread by flies?
How may disease germs be kept from the bodies of flies?
How can we protect ourselves against flies?
Where are young flies found?
What is a *maggot?*
How may flies be prevented from developing?
What harm is done by mosquitoes?

How can you tell the kind of mosquito which produces malaria?

What is the cause of yellow fever?

How may malaria and yellow fever be prevented?

Where do young mosquitoes live?

How can we get rid of mosquitoes?

What harm is done by cockroaches? How can we get rid of them?

What disease may be spread by lice? What are *nits?*

How may lice and nits be removed from the hair?

What harm do bedbugs do?

How do fleas help to spread the plague?

What have rats to do with the spread of the plague?

How can we get rid of rats and mice?

What disease is often spread by stray dogs and cats?

If a cat or a dog has bitten a person, what should be done with the animal?

If a person is bitten by an animal that has hydrophobia, what should be done to prevent him from taking the disease?

What should be done with a sick pet?

For the Teacher. — The subject of vermin is of great practical importance in hygiene. Insects have affected the history of nations by spreading the germs of malaria, yellow fever, plague, and typhus fever among the people. Typhus fever and plague are kept out of the city of New York to-day only by the great precautions which are taken against the admission of rats, fleas, and lice from foreign ships.

Collect some maggots and pupas from a stable or manure pile and show them to the class. If a pupa is opened carefully, a young fly may sometimes be found ready to emerge. Show how flies may be destroyed in their breeding places.

While not all kinds of mosquitoes spread diseases, yet all are annoying nuisances. Collect some wigglers and let the pupils observe them for a number of days and watch the full-grown mosquitoes emerge. Take the pupils to a marsh or rain barrel where mosquitoes are breeding and show them how the breeding could be prevented. Emphasize the fact that persons often grow mosquitoes in uncovered rain barrels and cesspools in their own back yards.

Head lice may spread disease just as body lice may spread it. A standard way to get rid of head lice is to rub a good quantity of a mixture of equal parts of kerosene and olive oil into the hair, do the head up in a towel, and let the mixture remain for at least six hours. Then wash the hair well in hot soapsuds. If any eggs survive, they will hatch in a week, and another application of the mixture will usually complete the extermination of the lice.

CHAPTER XX

FOOD ELEMENTS

Definition of Food. — Food has two uses; first, to become new flesh; and second, to be oxidized and supply the body with heat and power.

Any substance which may become a part of living flesh, or may be safely oxidized in the body, is a food.

Foods are mixtures of protein, fat, sugar, water, and minerals. These are the same kinds of substances that compose the flesh and bones of the body (p. 30).

Starch is a food substance which is nearly like sugar, and which is changed to sugar after it has been eaten. The starch in food may be counted as sugar. Starch and sugar are often called *carbohy'drates.*

Flesh-forming Food. — The living cells of flesh are composed principally of protein mixed with minerals and water (p. 31). The body does not make its protein out of other substances, but it takes bits of protein from digested food and adds them to the living flesh. A grown person doing light work needs about three ounces of protein each day in order to form new flesh in the place of that which becomes worn out. A food which contains a great deal of protein is called

a *flesh-forming* food. Examples of this kind of food are lean meat, eggs, and beans.

Fuel Food. — Most of the heat and power of the body comes from the oxidation of the fat and sugar which are contained in food. When fat and sugar are eaten, they are quickly oxidized, and neither of them becomes living flesh. They are like the coal which is burned in a boiler, but which cannot become a part of the machinery. The amount of fuel food which the body needs each day is about twelve ounces, or four times the amount of its flesh-forming food.

Protein is like the iron of which the boiler and machinery are made. But protein is also a fuel food, for worn-out flesh is protein which has been oxidized (p. 197).

A food which contains a great deal of fat, or sugar, or starch, is called a *heat-producing* food, or a *fuel* food. Examples of this kind of food are fat meat, potatoes, and grain. But these foods contain some protein, and are also flesh-forming foods.

Water and Minerals. — Water and minerals are needed in order to carry on the oxidation and the rebuilding of the body, and yet they themselves do not become oxidized or changed. They go to every part of the body with the other food substances, and help the flesh to make use of the protein, fat, and sugar. Minerals are found in nearly all kinds of food, and more salt than is needed is usually added to food, on account of its taste.

If food does not contain the proper minerals, the body is weak and does not grow. Softening and decay in teeth are often the result of a lack of minerals in the food of babies.

Vitamins. — The body also needs substances called *vi'tamins*, in order to grow and be strong. There are three principal vitamins:

1. Vitamin number one (or "A") is found in milk, and in cream and butter, and in leafy vegetables. A child who gets too little of this vitamin does not grow as fast as it should. Lack of this vitamin is also connected with a disease called *rick'ets*, in which the bones are soft and the joints enlarged.

2. Vitamin number two (or "B") is found in grains just beneath the outer coats of the kernels. Lack of this vitamin results in a nerve disease called *beriberi*, which is often found among people who live mostly on polished rice.

3. Vitamin number three (or "C") is found in fruits and fresh vegetables. Lack of it produces a disease called *scurvy*.

Every child needs milk, green vegetables or fruit, and cereals made from whole grain, every day on account of their vitamins and minerals.

Flavorings. — Pepper, vanilla, and other flavorings are often added to food in order to give it a pleasant taste. When food which has but little taste is eaten, the body cannot make the best use of it. The use of flavorings is to help the body to digest its food.

Taste is also a great help in judging the purity and healthfulness of food. If a food has a bad taste, it is usually not healthful.

Waste Substances in Food. — The body cannot make use of such things as bones, tough strings of flesh or fiber, the seeds and skins of fruit, and the husks of grain. All foods contain some of these waste substances, but they form the greater part of the solids of some foods, such as cabbage and turnips. Yet foods which contain a large amount of waste substances may be useful on account of their taste and their effect on digestion (p. 200).

Alcohol as a Food. — Alcohol cannot become flesh. It may be oxidized in the body, and may give off heat, and therefore some persons would call it a food. The body is not made in such a way that it can oxidize alcohol with safety. Using alcohol as a food for the body is like using it as fuel in a coal stove. Alcohol cannot be safely oxidized in the body, and it is not a true food.

Food Values. — The usefulness of food to the body is measured in two ways:

1. By its flesh-forming value.
2. By its fuel value.

Flesh-forming Value. — The flesh-forming or growth-producing value of a food depends principally on its protein, and in part also on its minerals and vitamins.

There are many kinds of protein. The body needs about eighteen kinds, just as one needs many kinds of

lumber in building a house. A food may contain some kinds of protein which the body cannot use, or it may lack some kinds which the body needs. The right kinds and amounts of protein that the body needs are found in milk, and therefore milk has a high flesh-forming value. Next in value are the proteins of eggs and meat, then those of cereals, and lastly those of vegetables and fruits. About one sixth of the protein must be of animal origin, such as milk, eggs, meat, or fish. If the body does not get some of these foods, it becomes weak, and loses weight.

Effect of Vitamins

The larger pig is the younger, but it was fed some green stuff every day. The smaller pig got only grain, which lacks one kind of vitamins; but when it was fed green stuff, it soon caught up with the other pig in size.

Protein will not become flesh unless minerals and vitamins are also present. Green vegetables and fruit contain very little protein or fuel substances, and yet a person cannot live well without them, for they supply minerals and vitamins.

The growth-producing values of foods are tested by means of experiments in feeding white rats, guinea pigs, and other lower animals, and by the observations of farmers in feeding pigs and other domestic animals. These experiments show the food requirements of the

human body, for the living flesh of lower animals grows in the same way as that of man.

Fuel Value of Food. — The fuel value of food is shown by the number of *calories* of heat which the food will produce when it is oxidized (p. 172). The fuel foods are fat, sugar, and starch. Protein also has a fuel value, for nearly all the protein which is built into living flesh takes the place of other protein which has been oxidized.

A man doing very light work produces about one hundred calories of heat each hour. He produces heat about as fast as two burning candles.

If you know how many calories each kind of food will produce, you can reckon how much food you need to eat. If an ounce of protein, or sugar, or starch is oxidized, it will yield about one hundred and twenty calories. An ounce of fat will yield about two hundred and forty calories.

If a man should eat nothing but protein, his body would require about twenty ounces a day, or about as much as is contained in the whites of nine dozen eggs, in order to furnish the 2400 calories that he needs. If he should eat nothing but fat, about ten ounces of butter would supply the calories that he needs. If he should use only sugar for food, he would need about one and a quarter pounds each day. But he cannot live on either kind of food substance alone. A person needs to eat a mixture of protein, fat, and sugar in order to be healthy.

Amount of Food. — In reckoning how much food to eat, first choose enough protein to replace that which is worn out and oxidized in the flesh. The amount of protein which will be needed is about three ounces a day (p. 240). This quantity of protein will produce three hundred and sixty calories of heat, which is about one sixth as much as the body needs. The remaining 2040 calories could be obtained from four ounces of fat and nine ounces of starch or sugar, or from two ounces of fat and thirteen ounces of starch or sugar. A person who does hard work will need much more than these amounts of food substances.

Concentrated Food. — Some persons think that there are foods which are so concentrated and nourishing that a teaspoonful of them mixed with a glass of water will supply the body with as much food substance as a full meal of bread and meat. This is not so. About a small teacupful of pure, dried protein is needed each day in order to rebuild the worn-out flesh, and nothing else will take the place of that quantity of protein.

The most concentrated fuel foods are butter and lard, and about a cupful of either one is needed to supply the daily needs of the body. Two cupfuls of the purest and most concentrated food is the very least that will keep a person in good health.

A tablespoonful of meat extract, or beef tea, or peptonized food, does not contain any more nourishment than a tablespoonful of milk. These substances may have a value as medicines, but they have very little

food value. The nourishment in any food consists in its protein, fat, and sugar or starch, and these substances must be in quantities that are measured by cupfuls rather than by spoonfuls.

Composition of Food. — If you know the composition of the various foods, you can tell what ones to choose in order to supply the needs of the body. Those who buy supplies for armies reckon the composition of the food so that they can buy the right amounts of protein, fat, and sugar to supply the needs of the soldiers. Farmers often choose the food for their cattle by means of tables of the compositions of different kinds of hay and grain. The table on the following page shows the composition of common foods.

Balanced Diet. — A group of foods which supply the body with all needful food substances without waste is called a *balanced diet*. A day's balanced diet for a man doing light work will contain minerals and vitamins, and the following amounts of other food substances:

Protein,	3 oz.,	yielding	360	calories.
Fat,	4 oz.,	yielding	960	calories.
Sugar or starch,	9 oz.,	yielding	1080	calories.
			2400	calories.

An abundance of minerals and vitamins is found in most fresh foods in their natural states; but both are often lacking in prepared foods, such as fine, white flour, granulated sugar, and rice with polished grains such as is usually sold in grocery stores.

Foods	Water per Cent	Protein per Cent	Fat per Cent	Sugar and Starch per Cent	Minerals per Cent	Calories in Each Pound
White flour	12.5	11.0	1.1	74.9	0.5	1695
Whole-wheat flour	11.4	13.8	1.9	71.9	1.0	1700
Corn meal	11.6	8.4	4.7	74.0	1.3	1760
Oatmeal	7.3	16.1	7.2	67.5	1.9	1880
Corn meal mush	60.7	5.5	4.8	27.5	1.5	820
White bread	29.9	8.9	4.1	56.0	1.1	1400
Rice, boiled	72.5	2.8	0.1	24.4	0.2	525
Dried lima beans	10.4	18.1	1.5	65.9	4.1	1665
Boiled potatoes	75.5	2.5	0.1	20.9	1.0	455
Tomatoes, fresh	94.3	0.9	0.4	3.9	0.5	105
Cooked beets	88.6	2.3	0.1	7.4	1.6	190
Fresh asparagus	94.0	1.8	0.2	3.3	0.7	105
Green corn, kernels	75.4	3.1	1.1	19.7	0.7	480
Apples, sliced	84.6	0.4	0.5	14.2	0.3	300
Banana pulp	75.3	1.3	0.6	22.0	0.8	470
Peaches	89.4	0.7	0.1	9.4	0.4	195
Peanut kernels	9.2	25.8	38.6	24.4	2.0	2440
Roast beef	48.2	22.3	28.2	0.0	1.3	1510
Lean ham, cooked	60.0	25.0	10.0	0.0	5.0	865
Dried beef	44.8	39.0	5.0	0.0	11.2	940
Chicken	74.8	21.5	2.5	0.0	1.2	500
Fresh codfish	80.0	18.5	0.5	0.0	1.0	375
Salt codfish	53.5	21.5	0.3	0.0	24.7	420
Cooked bluefish	68.2	26.1	4.5	0.0	1.2	670
Canned crab meat	80.0	16.5	1.5	0.0	2.0	375
Hen's eggs	73.7	14.0	11.0	0.0	1.0	690
Oyster meat	88.3	6.0	1.3	3.3	1.1	230
Cow's milk	87.0	3.3	4.0	5.0	0.7	315
Cream cheese	34.2	25.9	33.7	2.4	3.8	1840
Butter	11.0	1.0	85.0	0.0	3.0	3285
Sponge cake	15.3	6.3	10.7	65.9	1.8	1795
Custard pie	62.4	4.2	6.3	26.1	1.0	825

Table Showing the Composition of Common Foods, and the Number of Calories Produced by Their Oxidation

If too much protein is eaten, all over three ounces a day either will be wasted or will be oxidized as fuel food. But protein is not a good fuel food, for its oxidized products are not excreted so easily as those of fat and sugar. Eating too much protein is a common cause of kidney diseases.

The fat in a balanced diet will supply somewhat fewer calories than the sugar and starch. But since fat yields twice as much heat as sugar or starch, the amount of fat that is needed is less than half the quantity of the sugar and starch.

Some foods contain a great deal of flesh-forming substances, and only small quantities of substances that are heat-producing. Examples of these kinds of food are lean meat and the whites of eggs. Other foods consist mostly of heat-producing substances. Examples of these kinds of food are potatoes and rice. A mixture of meat and potatoes helps to make a balanced diet, for each has an abundance of what the other lacks.

Most vegetable foods contain a great deal of sugar or starch, and only a small quantity of protein and fat. Most animal foods contain a great deal of protein and fat, and little or no sugar or starch. A mixture of vegetable and animal foods will usually form a better balanced diet than either group alone.

The Arithmetic of Dieting. — The following examples show how we may calculate the value of a food.

Example 1. How many calories will a pound of white bread produce?

From the table on p. 248 we find that bread is 8.9 per cent protein, 4.1 per cent fat, and 56.0 per cent starch. The number of ounces of protein in a pound of bread is 16 times 0.089, or 1.42 ounces. The number of calories which the protein will produce is 1.42 times 120, or 170 calories.

The number of ounces of fat in a pound of bread is 16 times 0.041, or 0.65 ounce. The number of calories which the fat will produce is 0.65 times 240, or 156 calories.

The number of ounces of starch in a pound of bread is 16 times 0.56, or 8.96. The number of calories in the starch is 8.96 times 120, or 1075 calories.

The total number of calories in a pound of white bread is therefore $170 + 156 + 1075$, or 1401 calories.

In like manner the number of calories given in the last column of the table on p. 248 may be calculated for each kind of food. The numbers given are approximate, ending in 0 or 5, according to the custom in tables of this kind.

Example 2. If a person were to live on bread alone, how much would he need in a day?

We first calculate how much bread he should take in order to get three ounces of protein a day. From the table on p. 248 we find that about one eleventh of bread is protein. In order to get three ounces of protein, thirty-three ounces of bread, or about two pounds, will be needed. The precise calculation is $3 \div 0.089 = 33.7$ ounces.

By looking at the table on p. 248 we find that a pound of bread will produce about 1400 calories. Thirty-three ounces ($2\frac{1}{16}$ pounds), therefore, produce about 2885 calories, which is slightly more than the body needs. If the amount of bread is lessened so as to produce 2400 calories, the quantity of protein will be lessened to about two and one half ounces, which is too little for the daily needs of the body. Bread alone is, therefore, not a perfectly balanced diet.

Example 3. If a person were to live on bread and butter, how much would he need in a day?

If butter is spread rather thin, it will weigh about one tenth as much as the bread. The thirty-three ounces of bread given in Example 2 will have about three and one half ounces of butter on it. From the table on p. 248 we find that a pound of butter contains very little protein, but it produces 3285 calories. Therefore, three and one half ounces of butter will produce 718 calories. The total number of calories produced by the thirty-three ounces of bread and the three an one half ounces of butter will be about 3600 calories.

The proper number of calories, or 2400, will be obtained from two thirds of thirty-three ounces of bread, or twenty-two ounces, and two thirds of three and one half ounces of butter, or about two and one half ounces. But in this quantity of bread and butter, there are only two ounces of protein, which are only two thirds as many as the body needs. A bread and butter diet is therefore not well balanced.

Example 4. If a person were to live on ham sandwiches, how much of that food would he need in a day?

From Example 3 we find that thirty-three ounces of bread, spread with butter, will contain three ounces of protein, and will produce 3600 calories. About half a pound of lean boiled ham sliced thin will be used in making the bread and butter into sandwiches. From the table on p. 248 we can reckon that the ham will contain about two ounces of protein, and will produce about 432 calories. The sandwiches will therefore contain five ounces of protein, and will produce about 4030 calories. Three fifths of the sandwiches will contain three ounces of protein, and will produce about 2400 calories. One large loaf of bread (twenty ounces), with enough butter and ham to make sandwiches, is sufficient food to supply all the calories and protein that one person needs in a day; but some fresh fruit and vegetables will also be needed in order to supply sufficient vitamins and minerals.

QUESTIONS

Give a definition of food.

What are the uses of food?

What are the five useful substances which compose foods?

What substances does a flesh-forming food contain?

What substances do heat-producing foods contain?

What foods contain mineral substances?

What are vitamins? What foods contain vitamins?

Name some of the waste substances which are contained in food. Of what use may they be?

Give a reason why alcohol might be called a food.

Give some reasons why alcohol is not a true food.

How much protein does a grown person need to eat each day?

How is the flesh-forming value of a food indicated? the fuel value?

What is a *calorie?*

How many calories of heat does a person's food need to produce in a day?

How many calories does an ounce of protein produce? an ounce of fat? an ounce of sugar? an ounce of starch?

Why is a teaspoonful of concentrated food a day not sufficient for a man?

What is a *balanced diet?*

What food substance will form a balanced diet?

Look at the table on p. 248 and reckon what quantities of potatoes and fresh codfish will be needed in order to supply a person with all the protein and fuel food he requires in a day.

For the Teacher. — While the subject of food elements is complicated and scientific, yet its foundation principles may be readily understood, if they are presented simply and logically. Refer to Chapter III and review the composition of the body.

There are four classes of foodstuffs:

1. Flesh-forming, or those containing much protein.
2. Fuel, or those containing much starch, sugar, or fat.
3. Vitamins and minerals. These constitute almost the entire food value of greens, salads, and juicy fruits.
4. Flavorings, which are needed in order to stimulate the processes of digestion, for tasteless food is not easily digested.

There are three common measures of food values:

1. The protein content of food, or rather its content of the kinds of protein which the body can use.
2. The total calories that the food can yield on oxidation. Refer to Chapter XV and review the topic of calories.
3. The vitamin and mineral contents. These vary widely from practically nothing in white flour, to considerable in milk, greens, salads, and juicy fruits.

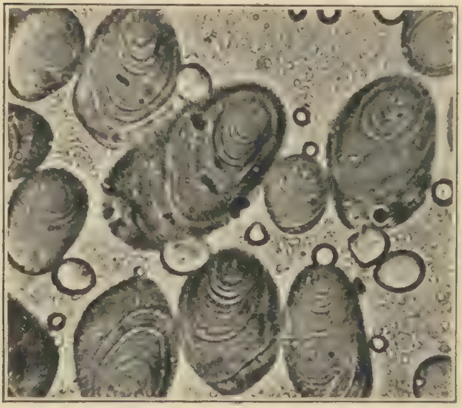
A balanced diet is a day's menu which supplies all kinds of food elements in their proper proportions. It can be reckoned by reference to tables of the composition of various foods like that on page 248.

Coördinate this chapter with arithmetic by calculating the calories in various foods, such as those in the examples which are given.

CHAPTER XXI

DIGESTION

Changes Produced by Digestion. — The forms of protein, fat, and sugar which can enter the blood are seldom found in food before it is eaten, but they are produced by changes which take place in food after it has been swallowed. The change of food which has been eaten to forms which can enter the blood is called *digestion* (dĭ-jĕs′-chun).



Grains of Potato Starch

(Magnified 300 times.) The starch is in layers which are separated by a substance like paper. Heat bursts the grains.

Cooking. — The work of digestion is begun outside of the body by *cooking*, or heating the food. Cooking softens and dissolves most foods and makes them ready to be digested within the body.

Starch forms the principal part of cereals and vegetables, and is in the form of microscopic grains. The

starch in each grain is in layers which are separated by thin sheets of an indigestible substance like paper. When food is cooked, the heat causes the grains to swell and burst. The digestive juices can then easily reach the starch.

Much of the protein of meat and vegetables is in a tough, hard form which cannot be easily softened by the digestive juices. Cooking softens the protein and allows the digestive juices to reach every part.

The fat in nearly all kinds of food is held in tiny pockets of protein (p. 32). Cooking softens the pockets and sets the fat free.

Changes Produced by Digestion. — Nearly all of our food was once a living part of an animal or plant. The protein, fat, sugar, and starch of food are complex substances which animals and plants have built up from simpler substances. When a man digests food, he tears the complex foods to pieces and breaks them up into the simpler substances of which they are composed. He then uses the simple substances in building his own blood and flesh. The process is like that of tearing down a house and using the old boards, bricks, and nails in building a new house.

The protein of human flesh is composed of about eighteen kinds of simple substances, called *am'ino acids*. These and other kinds of amino acids are found also in protein food. The digestion of proteins consists in tearing these amino acids apart from one another, and from other kinds which the body cannot use.

Fats are composed of simpler substances, called *fatty acids*, joined to glycerin. When a fat is boiled with soda, the fatty acid leaves the glycerin and unites with the soda to form soap. When fat is digested, it is broken into a fatty acid and glycerin, and the fatty acid unites with soda or potash to form soap. The digestion of fat produces soap and glycerin.

A fat will not dissolve in water, but if the fat is shaken with water containing soap, it is broken into microscopic drops which float in the water and produce a white liquid called an *emul'sion.* Milk is an emulsion of butter fat. An emulsion of fat is produced during digestion.

Starch and sugar are complex substances which are changed by digestion to a simple form called *glu'cose*, or grape sugar.

Enzymes. — The principal part of the work of digestion is done by means of substances called *ferments*, or *enzymes* (ĕn'zīmz). An enzyme will produce a continuous change in a substance without losing its own power of action or itself becoming changed. An example of the work of enzymes is the change of sugar to alcohol and carbon dioxide by yeast plants (p. 40).

Organs of Digestion. — Food is digested in a tube which begins at the mouth, and extends the whole length of the trunk of the body. The part of the digestive tube just back of the mouth is called the *phar'ynx* (făr'ĭngks), and the next part of the tube is called the *esoph'agus.* The pharynx is a muscular box which

squeezes food into the esophagus at the beginning of an act of swallowing. The esophagus conducts the food into the stomach.

The *stomach* is so much larger than the rest of the digestive tube that it looks like a bag between the ends of two smaller tubes, the esophagus and the *intestine* (ĭn-tĕs′tĭn). It is composed of muscle, and holds about two quarts. It lies crosswise of the body, mostly on the left side between the ribs and the waistline.

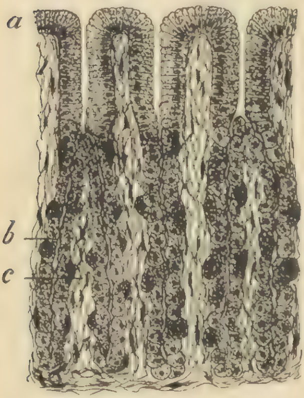
The *intestine* is the part of the digestive tube which is below the stomach. It is a thin, muscular tube, somewhat larger than a person's thumb, and about five times as long as his body. It lies in coils and nearly fills the lower part of the trunk of the body. Another name for the intestine is the *bowel.* The lower fifth of the intestine is two or three times as large as the upper four fifths, and is called the *large intestine.*

Fluids of Digestion. — The body digests food by dissolving it in liquids which are produced by glands in the mouth, the stomach, and the intestine.

The liquid in the mouth is called the *sali′va.* It contains enzymes which change starch to grape sugar. It is produced by six organs called the *sal′ivary* glands. Two of them lie in front of the ears, two under the sides of the lower jaw, and two under the front part of the tongue. These glands are swollen during the sickness called *mumps.*

The digestive fluid in the stomach is called the

gas'tric juice. It contains an enzyme, called pepsin, which changes protein to amino acids. It is poured out by the lining of the stomach in the same way that perspiration is poured out by the skin. It is formed in thousands of tiny glands which stand side by side, like pin pricks, in the mucous membrane of the stomach.



GLANDS OF THE STOMACH

(Magnified 200 times.) They stand closely packed side by side, and produce gastric juice. *a*, surface of stomach; *b*, gland; *c*, connective tissue.

The fluids of the intestine are the intestinal juice, the pancreatic (păng-krē̇-ăt'ik) juice, and the bile. The intestinal juice is produced by glands which lie in the mucous membrane of the intestine, and which are like the glands in the stomach.

The pancreas (păng'krē̇-ăs) is a large gland which lies behind the stomach. It manufactures a liquid, called the *pancreatic juice*, which it sends into the upper part of the intestine through a small tube.

The liver is a large gland which lies under the ribs on the right side of the body. It produces a bitter, yellow liquid, called the *bile*, which flows into the intestine through the same tube through which the pancreatic juice flows. The bile is a waste substance, but it assists in the work of digestion.

The work of the mixture of liquids in the intestine is to change starch and sugar to grape sugar, and protein to amino acids, and to make fats into an emulsion and change them to soap and glycerin. Thus the mouth begins the digestion of starch, the stomach begins the digestion of protein, and the intestine digests all kinds of food.

Time Required for Digestion. — Digestion begins almost as soon as food enters the mouth, and some of the food is ready to enter the blood within ten minutes after it has been swallowed. The stomach will usually be empty in about three hours after eating, but the digestion of food will continue for about six hours in the upper intestine, and for twelve hours in the large intestine.

Peristalsis. — The greater part of the flesh of the esophagus, stomach, and intestine consists of involuntary muscle (p. 79). The use of the muscle is to force the food down the digestive tube. It contracts in ringlike waves which run down the esophagus, stomach, and intestine, and force the food onward, just as if each wave were a ring running slowly down the digestive tube. This motion is called *peristalsis* (pĕr-ĭ-stăl′sĭs). When food reaches any part of the digestive tube, peristalsis begins in that part, and the motion of the part usually stops as soon as food has passed it.

The stomach and intestine force the food onward with a slow and gentle motion that is not usually felt.

But if the wrong kind of food is eaten, the muscles may act rapidly and forcibly in order to push the harmful food out of the body. The peristalsis then causes the kind of pain which is called *stomach ache*.

When a harmful kind of food is swallowed, the waves of peristalsis sometimes run backward and force the food back into the mouth. This backward motion of food into the mouth is called *vomiting*.

Exercise during Digestion. — Digesting food requires the muscles of the stomach and intestine to work. If you exercise or study hard near a mealtime, you may use up your strength, and may not have strength left to digest your food properly. Take a few moments for rest after each meal.

Bacteria in the Intestine. — The intestine contains great numbers of living bacteria which are very much like the bacteria of decay outside of the body. They live upon that part of food which does not become digested, and as they grow, they cause the food to decay. The food is then as poisonous as it would have been if it had been spoiled when it was eaten. Many of the bad feelings which are caused by poor digestion are due to the decay of undigested food. Getting rid of undigested food is an important part of digestion.

Chewing Food. — No one can control the digestion of food in the stomach and intestine, but the way in which a food is eaten has a great deal to do with the way in which it will be digested. If a food is eaten properly, it will usually be digested readily.

Grinding food to small bits in the mouth helps all the digestive fluids to dissolve it. A great deal of poor digestion comes from swallowing food in lumps which are too big for the digestive juices to dissolve easily. Chewing food is one of the most important steps in digestion, for it breaks the food into small pieces which the stomach and intestine can easily digest.

Mouth Digestion. — Another object of chewing food is to mix it with saliva. Each mouthful of food does not remain in the mouth long enough for much of its starch to be digested there, but the saliva continues to act for about half an hour after the food reaches the stomach. About half of the work of digesting starch may be done by the saliva, if food is eaten slowly.

The main part of the food usually eaten is starch. If starch is not digested by saliva, the intestine has to do double work to digest it. The food will then not digest well, and it will be the cause of headaches and stomach aches. If you chew soft food, such as oatmeal, long enough to mix it with saliva, you will help the stomach and intestine to digest it.

Eating Fast. — When you eat fast, you cannot chew your food well, or mix it with saliva. The stomach and intestine cannot do the work which the mouth should have done. If your food is not well digested in the mouth, a large part of it will escape digestion in the stomach and intestine. You will get no more nourishment from a large quantity of food eaten fast, than from a small quantity eaten slowly. A little food well

digested is better than a great deal half digested. If you have only five minutes for eating, you will get about as much nourishment by eating slowly as by eating fast. You cannot chew all your food well if you take less than fifteen minutes in eating a meal.

Drinking at Mealtimes. — Some kinds of food, such as soup, contain a great deal of water, and other kinds, such as crackers, are very dry; yet you can easily digest both kinds. Taking water with a meal may aid digestion, for it separates the bits of food, and enables the digestive enzymes to reach every part. You may safely drink water with a meal, if you are thirsty. But drinking water in order to be able to swallow food rapidly is harmful to the digestive organs.

Eating between Meals. — The muscles of the stomach and intestine become tired and need a rest, as the muscles of the arm do. The cells of the glands which produce the digestive juices also need to rest often. It is best to eat only at mealtimes, so that the stomach and intestine may have time to rest between meals.

How Much to Eat. — The feeling of hunger is a natural guide by which you can tell when to eat, and how much food to take. Hunger is usually a safe guide if you eat slowly and chew your food well. But your hunger and your appetite will often lead you to eat wrongly if you eat rapidly or if you take food for the sake of its taste, or for the pleasure of eating. If you eat slowly and only at mealtimes, you may safely eat enough to satisfy your natural hunger and appetite.

The Feelings and Digestion. — Your feelings have a great deal to do with the digestion of food. When you are hungry, the sight and smell of good food cause the saliva to flow into the mouth. If you enjoy the taste of food, the gastric juice will begin to flow into the stomach as soon as you begin to eat. But if you eat when you have no desire for food, or if the food has an unpleasant taste, or if you are sad or angry, neither the saliva nor the gastric juice will flow properly, and your food will not be well digested.

Politeness and good manners at table are great aids to digestion, for they make you happy and help you to enjoy your food. Other things which will help you to digest your food are good cooking, clean dishes, and pleasant conversation.

Rules for Eating. — Your stomach and intestine will usually digest all the food that you need if you eat it properly. Most persons who have indigestion have brought the sickness on themselves by eating either too rapidly, or too much, or too often. Their indigestion will usually stop, and their digestive organs will nearly always do their work well again, if they eat properly.

It is not hard to learn to eat properly. The rules of good table manners are excellent rules for eating in a healthful way. That is, it is good manners to eat slowly and not too much, to chew the food well, to be cheerful at the table, and to follow all the other rules of healthful eating.

QUESTIONS

What changes does cooking produce in food?

What changes does digestion produce in protein? in sugar and starch? in fat?

Describe the stomach; the intestine.

What is an enzyme?

What is the *saliva?*

What changes in food are produced by digestion in the mouth?

What is the *gastric juice?* How is it formed?

What changes does the gastric juice produce in food?

What fluids digest food in the intestine?

In what organs is starch digested? protein? fat?

What is *peristalsis?*

How much time is required for mouth digestion? for stomach digestion? for digestion in the intestine?

What effects are produced by bacteria growing in the intestine?

How does chewing food well assist the stomach and intestine to digest food?

Why is it necessary to chew soft foods, such as oatmeal?

Give some reasons why you should eat slowly.

What way of drinking at a mealtime is harmful?

Why is eating between meals harmful?

How can you know how much to eat?

In what respect are the rules of good table manners also good rules for heathful eating?

For the Teacher. — It is extremely seldom that any plain food will "disagree" with any person if it is eaten in the proper way and at the proper time. Continually thinking about one's stomach is likely to produce the discomforts which are ascribed to indigestion.

Emphasize the value of milk, vegetables, and fruit in promoting the appetite and digestion. Deficiency in the amount of foods containing vitamins is a common cause of a poor appetite. The older books describe peptone as the product of digestion of proteins. Advances in knowledge have shown that amino acids are the basic substances out of which proteins are built, and that about eighteen kinds are yielded by the digestion of the common proteins in foods. Peptone is a name given to protein substances in a stage of digestion intermediate between proteins and amino acids.

CHAPTER XXII

ABSORPTION AND ASSIMILATION

Absorption of Food. — Digested food is a whitish liquid which looks like thin cream. It is mixed with the indigestible parts of the food and with many waste matters of the body. It is of no use to the body until after it has passed into the blood. The passing of digested food into the blood is called *absorp'tion.*

A large quantity of blood flows through a network of capillaries which lie very near the surface of the mucous membrane of the intestine. All that separates the food from the blood is a thin partition composed of a single layer of epithelial cells and the thin walls of the capillaries. This partition is as thin as tissue paper, and allows water, minerals, and digested protein and sugar to pass through it readily and enter the blood stream.

Osmosis. — The mingling of unlike liquids and gases which are separated by a thin partition through which they can pass is called *osmo'sis.* The absorption of digested food into the blood is an example of osmosis. The following experiment will illustrate the process:

Carefully remove some of the shell from the large

end of an egg, taking care not to break the thin membrane which lines the shell. Set the broken end of the egg into a small glass of water, and make a small hole through both the shell and the lining in the upper end. A large amount of water will pass into the egg, and will cause the white of the egg to overflow through the upper hole within fifteen minutes. The force which causes water to flow through the membrane and into the egg is that of osmosis. A small quantity of substance from the egg will also pass into the water, but it will be much less than the amount of water which passes into the egg.

AN EXPERIMENT IN OSMOSIS

The white of the egg is separated from the water by the lining of the eggshell. Water passes through the lining and fills the egg so full that some of its white overflows through the hole in the top of the egg.

Osmosis in the Intestine. — The epithelial cells of the intestine and the walls of the capillaries form a thin membrane which is like the lining of the eggshell. The force which causes digested food to pass through the membrane into the blood is that of osmosis.

Other Examples of Osmosis. — The exchange of oxygen and carbon dioxide in the air sacs of the lungs, and that of oxygen and waste substances between the capillaries and the cells of the body, are examples of osmosis.

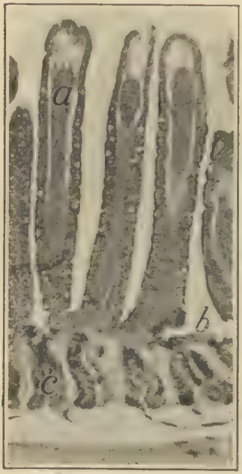
Changes in Absorbed Food. — The epithelial cells of the lining of the intestine begin the work of rebuilding protein and fat out of the simple forms which were produced by digestion. The cells combine the amino acids and make them into the proteins which are found in the blood. They tear apart the soap which was produced by digestion, and rebuild it into fat. The glucose, minerals, and water are not changed as they pass through the epithelial cells.

The Liver. — The blood stream which leaves the intestine carries the absorbed protein and sugar to the liver. The cells of the liver change some of the sugar to a form called *gly′cogen*, and store it for use between meals. The liver cells also remove harmful substances which may have been absorbed, and send them, with the bile, back to the intestine.

Absorption of Fat. — The cells of the epithelium of the intestine do not pass the absorbed fat into the capillaries, but into lymph tubes, called *lacteals* (lăk′tē-alz). The lacteals unite in a large tube called the *thoracic* (thō-răs′ĭk) *duct*, which conducts the digested fat into a large vein near the heart.

Villi. — The mucous membrane of the intestine is covered with tiny projections, called *vil′li*, which look

like the short threads on velvet. Each villus contains a lacteal and a great number of capillaries. The villi are like tiny roots. They extend into the liquid food and take it up quickly.



Villi and Intestinal Glands

a, villus; *b*, inner surface of the intestine; *c*, glands in the mucous membrane.

What the Body Does with Food. — Putting digested food to use throughout the body is called *assimila'tion*. The blood carries a stream of digested food to every living part. Flesh that has lost some of its substance by oxidation takes up protein, minerals, and water, and repairs itself with them. Glands take what they need in order to form their juices. Muscles take up sugar and fat, and oxidize them to produce heat and power. Each part of the body takes the substances which it needs.

Undigested Food. — The parts of food which are not digested are slowly forced along the intestine, and are finally expelled from it. The intestine also expels the bile and other excretions which the liver has taken from the blood. Expelling waste matters and undigested food is the last act of digestion, and is as important to health as eating.

Some foods, such as vegetables and brown bread,

contain strings and fibers which are like wood, and which do not become digested or decayed in the intestine. Harmless indigestible substances like these are necessary for health, for they help the peristalsis of the intestine.

Overeating. — The cells of the body will not use more food than they need, even though the blood brings a large quantity of food to them. Overeating may cause the body to store up great quantities of fat, but the fat is a weight which is often a burden instead of a help.

The cells of the body cannot use more fuel food than they can oxidize. If a person sits still, or does very light work, he takes only a small quantity of oxygen into his body, and oxidizes only a small amount of food. If the blood takes up more food than the body can oxidize, some of the food will be half oxidized. The excretions will then be poisonous, and will cause headaches, rheumatic pains, and kidney diseases. One of the principal causes of these forms of sickness is overeating. If you suffer from the effects of overeating, the cure is either to eat only a little food for a few days, or to take a great deal of exercise, in order to oxidize the extra food in your blood.

Growing Fat. — Thin persons often try to grow fat by eating all that they can. This will not always make them fat, for the food may not be digested, and the cells of the body may not make use of that which has been digested. But many persons gain flesh when

they eat less food than usual, and eat it properly, for the food may then be well digested, and the cells may get the right kinds and amounts of food that they need.

Growing Thin. — A stout person can get rid of his fat by eating so little food that his body has to oxidize its fat. In order to get rid of ten pounds of fat in a month, a person must oxidize about five ounces of fat each day. Five ounces of fat will produce 1200 calories of heat, or about half the heat which a man's daily food produces (p. 247). If a person eats only half as much food as he requires, his body will oxidize its fat, and he will become thin.

WEIGHING AND MEASURING CHILDREN AT SCHOOL

Another way of getting rid of the fat in the body is to take a great deal of hard exercise in order to compel the body to oxidize its fat.

Poor Nourishment. — Young persons who are healthy and strong will grow constantly and regularly. Tables of standard heights and weights have been made for each year of their age. A child whose height and weight are less than the standard for his age is said

to be poorly nourished. Children are regularly measured and weighed in many schools, and those who are poorly nourished are taught how they may grow to the proper size and strength.

The following table shows the height and weight of an average healthy American child at each year of its age:

Age	BOYS Height Inches	BOYS Weight Pounds	GIRLS Height Inches	GIRLS Weight Pounds
1	29	21	28.5	19.5
2	33.5	26.5	33	25
3	36.5	30.5	36	29.5
4	39	34	38.5	33
5	41.5	38	41	37
6	44	41	43.5	40
7	45.5	49	45.5	47
8	47.5	54	47.5	52
9	49.5	59	49	57
10	51.5	65	51	62
11	53	70	53	68
12	55	77	56	78
13	57	85	58	89
14	60	95	60	98
15	62	107	61	106
16	65	121	61.5	112

There are three principal causes of poor nourishment:

1. Diseases and defects of the body.
2. Overwork or lack of rest.
3. Wrong food or wrong habits of eating.

Common diseases and defects which prevent growth are enlarged glands of the neck, tuberculosis, decayed teeth, adenoids, and tonsils which are diseased. An examination of a child will show whether or not any of

these conditions are present. If they are, they usually must be corrected before a child will grow.

Too much activity and too little rest will prevent growth by causing food to be oxidized as fast as it is taken into the body. Common acts which prevent growth are sitting up late, attending parties and moving picture shows at night, going on visits often, and trying to act as grown people do. It is natural and healthful to work and play hard during the day and to be tired at night; but long hours of sleep are needed in order that the body may rebuild its worn parts. A child may need to take a nap after the noon lunch in order to gain weight.

Poor nourishment may be the result of wrong habits of eating (p. 261), or the wrong choice of food (p. 247). A person who lacks a necessary food element has little appetite for any kind of food. Children who do not eat green vegetables, fresh milk, and fruit often have no appetite because they lack vitamins; and yet they may eat candy, cake, and ice cream because they like the taste of sweets. Forcing children to eat does not cause them to grow, for the body will not use the food unless vitamins are present. The best way to make the appetite return is to allow the child nothing to eat except the proper food. The child may skip a meal or two; but when he begins to take vegetables, fruit, and milk, the vitamins will cause the appetite to return, and the child will eat the proper food and will grow naturally.

Metabolism. — Two opposing actions are constantly taking place in the body:

1. Upbuilding, or taking food into the body and making it into living flesh.

2. Destruction, or oxidizing food and flesh and excreting the oxidized products.

The processes of upbuilding and destruction in the living body are called *metab′olism.* The body of a healthy grown person carries on its metabolism perfectly and smoothly. The substances taken into his body exactly balance those excreted; the weight and appearance of his body remain the same from day to day; and the amount of heat and power developed is exactly the amount which the excretions show could be developed from the food and flesh which were oxidized. The processes of eating, growth, oxidation, heat, work, and excretion are all related closely and exactly, and each may be an indicator of the extent and perfection of the other processes. For example, a physician collects the expired breath of a sick person and tests its amount of carbon dioxide in order to estimate the rate of oxidation and the amount of food which the body requires.

Thyroid Gland. — Metabolism is largely under the control of certain glands in the body. One of these is the *thy′roid* gland, which lies in the neck in front of the trachea. It is sometimes enlarged and diseased and produces a swelling called a *goi′ter.* The substance which it forms has a great effect on metabolism,

especially on oxidation. If the substance is increased in amount, oxidation goes on rapidly and the body loses weight. If the substance is lacking, oxidation takes place slowly, the body increases in weight and becomes fat, and the person is dull and lazy. If a person who lacks the thyroid substance is given the thyroid of a sheep or other lower animal, his metabolism may become normal.

The effect of the thyroid gland on growth may be shown by experiments on tadpoles. If tadpoles are fed with small amounts of thyroid gland, they develop legs and change to the form of frogs and toads rapidly and while they are young and small. If the thyroid glands are taken out from the bodies of the young tadpoles, the tadpoles will continue to grow for years until they become large in size, and yet they will not produce legs or turn into fully-formed frogs and toads.

The growth and development of a child depend largely upon the thyroid and other glands. Children are sometimes dwarfed in both body and mind because they lack the proper gland substance.

QUESTIONS

What is *absorption?*
What are *villi?*
What changes occur as digested food passes into the blood?
What is *osmosis?*
How can you illustrate the process of osmosis?
What does the liver do to food after it is absorbed?
Describe the absorption of fat.
Where is fat taken after it is absorbed?

What is *assimilation?*

What does the body do with food after it is absorbed?

What are some of the bad effects of overeating?

How can a thin person become fat?

How can a fat person become thin?

Why is some food which cannot be digested necessary for health?

What are the three principal causes of poor nourishment?

What are some common defects which cause poor nourishment?

How does too much activity cause poor nourishment?

What effect has the proper choice of food upon the appetite?

What is *metabolism?* How may the excretion of carbon dioxide indicate the perfection of the process of metabolism in the body?

What effect does the thyroid gland have on metabolism?

For the Teacher. — This chapter deals with nutrition, or the uses to which food is put in the body. Emphasize the fact that growing stout or thin depends on the balance between eating and oxidation.

The subject of metabolism comes naturally at this place. The interrelation of the processes of eating, growth, oxidation, heat, work, and excretion may be mentioned. The effect of the thyroid gland and its extract on metabolism may also be stated.

The subject of poor nourishment is of great importance in dealing with children. A child that is ten per cent under weight for the average child of its age is considered to be poorly nourished.

Emphasize the three great causes of poor nourishment. Diseases and lack of rest are of equal importance with improper food in leading to under nourishment, and must be corrected before the child will grow.

One of the most common defects of diet is the lack of the vitamins which are found in milk and green vegetables. A child that drinks a quart of milk and eats some green vegetables, or salads, or fruit every day will take all the vitamins that are needed, and the child may then take whatever plain food is at hand. If vitamins are not taken, the child will have no appetite for food; but if food containing vitamins is eaten, the child will have an appetite for all kinds of plain food. Vitamins have an effect like that which old-fashioned "tonics" were supposed to have. Foods rich in vitamins have the same "tonic" effect on grown persons as they have on children.

Lean meat lacks the vitamins which produce growth, but these vitamins are found in glands such as the liver and kidneys. The value of cod-liver oil as a preventive of rickets consists in the vitamins which come from the fish livers. A cat fed on beefsteak alone will suffer from poor nutrition; but it will thrive on mice because it then obtains the vitamins which are found in the glands.

CHAPTER XXIII

FOODSTUFFS

Cost of Food. — A simple way of supplying ourselves with food would be to go to a market and buy pure protein, fat, sugar, and starch, and then mix them in the proper quantities. But no one does this, for the mixtures which are made from the pure elements are nearly always tasteless and unwholesome. The human digestive organs are suited to those mixtures of food elements in the forms in which they grow naturally in plants and animals.

The valuable parts of a food are the protein, fat, sugar, starch, minerals, and vitamins that are in them. Sugar and starch may be bought for about eight cents a pound, and fat for about fifteen cents a pound. The cheapest protein costs about thirty cents a pound. If a food costs more than these prices, the extra price is for its taste and appearance, and not for its flesh-forming or fuel value. The vitamins and minerals are as abundant in cheap foods as in the more costly ones. Fruits out of season are costly luxuries. The grains have the greatest food value of all foods, and yet they cost the least. They are also foods which a person can eat day after day without tiring of them.

The following table shows the cost of various foods each of which will contain three ounces of protein:

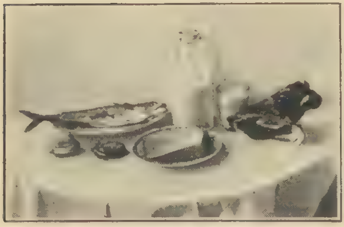
Oatmeal, $1\frac{1}{4}$ lb. at 5 cents	$0.06
Beans, 1 lb. at 10 cents	0.10
Corn meal, $2\frac{1}{4}$ lb. at 5 cents	0.11
Potatoes, 8 lb. at 2 cents	0.16
White bread, 2 lb. at 8 cents	0.16
Beef, dried, $\frac{1}{2}$ lb. at 40 cents	0.20
Cheese, $\frac{3}{4}$ lb. at 40 cents	0.30
Fresh codfish, 1 lb. at 30 cents	0.30
Beef, round, 1 lb. at 30 cents	0.30
Hen's eggs, 1 doz. at 40 cents	0.40
Cow's milk, 3 quarts at 16 cents	0.48
Chicken meat, 1 lb. at 50 cents	0.50
Beets, 10 lb. at 5 cents	0.50
Oysters, 3 pints at 40 cents	1.20
Bananas, 5 doz. at 40 cents	2.00
Apples, 40 lb. at 10 cents	4.00

The following table shows the cost of various foods, each of which will produce about 2400 calories of heat:

Oatmeal, $1\frac{1}{4}$ lb. at 5 cents	$0.06
Corn meal, $1\frac{1}{2}$ lb. at 5 cents	0.08
Potatoes, 5 lb. at 2 cents	0.10
White bread, $1\frac{2}{3}$ lb. at 8 cents	0.14
Beans, $1\frac{1}{2}$ lb. at 10 cents	0.15
Beef, round, $1\frac{1}{2}$ lb. at 30 cents	0.45
Cheese, $1\frac{1}{4}$ lb. at 40 cents	0.50
Milk, 4 quarts at 16 cents	0.64
Beets, 13 lb. at 5 cents	0.65
Apples, 8 lb. at 10 cents	0.80
Eggs, 2 doz. at 40 cents	0.80
Bananas, 2 doz. at 40 cents	0.80
Beef, dried, $2\frac{1}{2}$ lb. at 40 cents	1.00
Fresh codfish, 7 lb. at 30 cents	2.10
Chicken meat, 5 lb. at 50 cents	2.50
Oysters, 10 pints at 40 cents	4.00

Food Groups. — The foods in grocery stores, butcher shops, and other markets may be divided into four groups, as follows:

1. Animal foods.
2. Cereals and sugar.
3. Fleshy vegetables.
4. Leafy vegetables and fruit.



1. Animal foods

2. Cereals and sugar

3. Fleshy vegetables

4. Leafy vegetables and fruit

THE FOUR FOOD GROUPS

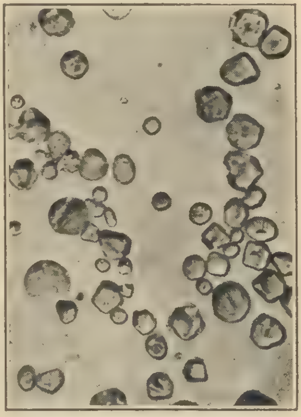
In the course of a day, eat at least one food from each group. Be sure to choose milk every day.

Cereals. — The different kinds of grain and the foods made from them are called *cereals*. There are no great differences in the composition and digestibility of the different kinds of grain. All the cereals contain

protein and a great deal of starch. The only cereals which contain much fat are oats and corn.

Bread, oatmeal, and other foods made from grain are the most useful and important of all foods. A person could live on them if some leafy vegetables or fruits were added in order to supply vitamins. Cereals and milk make a well-balanced diet.

Cereals are the cheapest of all foods. About ten cents' worth of corn meal will supply all the protein and all the calories that a man needs in a day.



GRAINS OF CORNSTARCH

Value of White Flour. — White flour is made by sifting out the white central parts of the ground kernels from the coarser, outer parts and the indigestible skins or bran. Most of the vitamins and minerals of grain are in the outer parts of the kernels, and so they are lacking in white flour. But white flour contains an abundance of protein and starch in forms which the body can readily use.

Bread. — Bread, biscuit, crackers, and plain cake are nearly alike in composition and digestibility. All these foods are full of bubbles, and are said to be *light*. The bubbles are made by carbon dioxide, which is formed when yeast or baking powder is added to wet

flour (p. 40). When the wet flour is baked, it hardens in the form of thin-walled bubbles, which may easily be chewed. Wheat flour may readily be made into light bread, for its protein becomes sticky when it is wet. The protein of corn meal does not become sticky, and so corn meal cannot be made into light bread unless it is mixed with wheat flour or eggs.

Fleshy Vegetables. — The principal fleshy vegetables are beans, peas, potatoes, sweet potatoes, and green corn. These contain a large amount of protein and can yield a large number of calories. Examples of vegetables having a smaller food value are beets, turnips, squash, and eggplant.

Beans and Peas. — Dried beans and peas are rich in protein and starch, but some of the protein is in a form which the body cannot use. They contain very little fat. They are not suited to persons who have weak stomachs, but they are excellent foods for hardy men who work out of doors, for in such persons the stomach usually grows strong with the muscles.

Peanuts and Nuts. — Peanuts are a kind of pea with hard pods like thin nutshells. They are like peas in composition, except that they have fat in the place of about half of the starch of peas. They cannot be digested easily, and if they are eaten between meals, they are as harmful as beans would be.

Most nuts are like peanuts in composition, digestibility, and food value.

Potatoes. — Potatoes and sweet potatoes are about three fourths water, one fortieth protein, and one fifth starch. They contain hardly any fat, but if they are cooked with meat, as in a stew, the mixture becomes a well-balanced diet. When potatoes are dried, they have about the same food value as the least nourishing of the grains.

Garden Vegetables. — The leafy and juicy vegetables, such as onions, cabbage, celery, and tomatoes, are mostly water, and contain very little protein, starch, or sugar, and hardly any fat. They have very little flesh-forming or fuel value. Yet if a person does not eat them at all, he becomes weak and sick, for they are the sources of vitamins and minerals.

Crews of ships on long voyages used to suffer with a disease called *scurvy*, in which the mouth and skin became tender and sore. The disease was caused principally by a lack of the vitamins that are found in fresh vegetables and fruit. The fully developed disease is now rare, for fresh vegetables and fruit are carried in a canned or preserved form. But milder results of an insufficient amount of fresh vegetables and fruit are often seen. The lack of energy that is sometimes supposed to be laziness, and the condition that is called *growing pains*, often disappear when the proper amount of fresh vegetables and fruit is eaten.

Fruit. — Dates, bananas, and grapes each contain a considerable amount of protein and a large amount of sugar. Almost the only food substance in berries,

apples, oranges, peaches, and most other juicy fruits is sugar. The skin and seeds of fruits cannot be digested at all, and the soft pulp cannot be digested so easily as cereal food. Most fruits have about the same food value as garden vegetables, and they can take the place of vegetables in a diet, for they contain vitamins and minerals. They are more expensive than vegetables, and are far more expensive than cereals. Dried fruits usually contain all the food substances that are found in fresh fruits except that the vitamins may be lacking.

Animal Foods. — Foods which come from animals, such as meat, eggs and milk, differ from vegetable foods in the following ways:

1. Nearly all vegetable foods are rich in sugar and starch. Few animal foods have any sugar or starch.

2. Vegetable foods usually contain but little fat. Animal foods usually contain much fat.

3. The fat of vegetables is usually hard to digest. Animal fats may be digested easily.

4. Animal protein is more nearly like the protein of human flesh than is the protein of vegetables; and so animal protein may be digested and built into human flesh more easily than the protein of vegetables.

A grown person could live on vegetable food, but most persons will be helped by eating some protein that comes from animal food. The young of human beings, higher animals, and birds all must have protein of animal origin in order to make good growth. Young animals get the protein from milk, and young birds

get it from worms and insects. The best form of protein for children is that in milk.

A danger in the use of animal food is that more than the required three ounces of protein will be taken, and the kidneys will be overworked in getting rid of its oxidized products. Since most animal foods are rich in protein, a small amount will supply all that the body needs. The foods themselves are usually healthful, and are harmful only when an excess is taken.

Meat. — The flesh of animals is called *meat*, but the word *meat* usually means the flesh of beef cattle, pigs, sheep, and chickens. Lean meat is about one fifth protein. Some kinds of meat contain a great deal of fat, and other kinds have very little fat, but no meat contains much sugar or starch. The different kinds of meat, such as beef, pork, and chicken, do not differ greatly in composition, or ease of digestion, but there are great differences in their cost.

Some persons suppose that the expensive kinds of beef, such as sirloin steak, are more nourishing and may be digested more easily than the cheapest kinds, such as meat from the neck of an animal. This is not so. There is very little difference in the food values of the various kinds of beef. The principal difference is in the toughness and taste of the meat, but a good cook can make tough meat as tender and as tasty as the dearer kinds of meat.

Fish. — The meat of fish is almost like the meat of cattle in composition and food value, except that it

usually contains more water, and is less easy to digest. It differs from beef principally in its taste. If fish is well cooked, it may take the place of meat. Protein in the cheaper kinds of fish is almost as cheap as it is in cereals. Dried codfish is one of the cheapest of all the flesh-forming foods.

Shellfish. — Oysters, clams, lobsters, crabs, and other shellfish are like fish and meat, except that they usually contain a little sugar, and a great deal of water. The food substances in them are about three times more expensive than in meat.

Shellfish are usually taken from the bottom of bays and creeks. If sewage empties into the water near them, they are likely to carry disease germs on their shells and in their digestive tubes. But if the shellfish are well cooked, the disease germs in them will be killed.

Eggs. — Eggs have about the same composition and food value as meat. They may usually be digested readily, whether they are raw or are cooked in any tasty way. Their ease of digestion depends principally on the size of the lumps which are swallowed. A raw egg may form a large mass which the digestive juices cannot readily enter. A hard-boiled egg may be quickly digested if it is chewed to small bits.

Milk. — Cow's milk is a complete and well-balanced food, for it contains protein, fat, sugar, and minerals in nearly the quantities that the body needs. One eighth of it is solid substance, and a cup of it contains

more solid food than a cup of oysters. A person doing light work would need no more food than four quarts of milk a day. It contains rather more protein than a grown person needs, but it is the best of all foods for young children, for they need a great deal of protein in forming new flesh while they grow in size. Milk is usually as cheap a food as cheap meat.

Milk may be digested readily, and it contains hardly any indigestible substances. It is one of the most valuable of all foods for persons who are sick or have weak stomachs.

Some persons often drink milk instead of water when they are thirsty, and are not in need of food. Milk is a food as well as a drink. Taking it between meals or after a meal is as harmful as taking any other food when the body has no need of it.

Foods Made from Milk. — The fat of milk is in tiny drops which float through its liquid and make it appear white. When the milk stands quietly for a few hours, the fat rises to the surface and forms a layer called *cream*. After the cream has been removed, the milk that is left is called *skim milk*.

Milk which contains a great deal of cream is called *rich* milk; if it contains a small quantity of cream it is called *thin* milk. Many persons suppose that thin milk and skim milk are of little value as food. Thin milk and skim milk each contain about as much protein and sugar as rich milk. Taking the cream from milk does not spoil it for food, for nearly all the protein

and sugar are left in the skim milk. The price of skim milk is only about half that of whole milk, but it has much more than half the food value of whole milk.

Cream is about one fifth fat, and contains about as much protein and sugar as milk itself. When it is shaken or stirred, its fat collects into a solid lump called *butter*. The liquid that is left is called *buttermilk*, and has about the same food value as skim milk.

Cheese. — The protein of milk becomes solid when the milk is mixed with a substance, called *rennet*, which contains the digestive juice of a calf's stomach. When the solid protein is pressed into a mass it is called *cheese*. Most cheese also contains a large quantity of fat. The flavor of cheese is caused by bacteria which grow either in the milk, or in the cheese after it has stood for a few days or weeks. Cheese is one of the most nourishing of all foods, and usually it may be digested easily.

Vitamins in Milk. — Milk is one of the best of all sources of the vitamins which cause growth. Every child needs milk every day; but as a child grows older, it can obtain the vitamins from green vegetables and salads. The vitamins in cow's milk come from the grass which the animal eats. Men can get the same vitamins from green vegetables.

Tea and Coffee. — Tea and coffee are two drinks which most persons have on their tables. Tea is made from the dried leaves of the tea plant, and coffee is made from the roasted berries of the coffee shrub. They each

contain a substance, called *caffeine* (kăf′ē-ĭn), which keeps a person awake, and rouses his mind to work. Tea and coffee are stimulants, and do not supply the body with any food substance. The drinks are of value to grown persons who have to do hard work. They also have a great value in some forms of sickness, but they do more harm than good to children. If you cannot work or keep awake without them, there is something the matter with you, and neither of the drinks will be of any real help to you.

Cocoa. — Cocoa and chocolate are drinks which are made from the roasted seeds of the cacao tree. They each contain a substance which is like caffeine, but is somewhat weaker. For this reason children can usually drink cocoa and chocolate more safely than tea or coffee.

Choice of Food. — When you buy food for a meal, choose the things that will make a well-balanced diet. You can do this by taking something from each of the four food groups that are mentioned on page 278.

A good bill of fare for a day could be as follows:

Breakfast	Lunch	Dinner
Apples	Vegetable soup	Boiled ham
Cream of wheat	Saltines	Baked potatoes
Sausage	Scalloped corn	Milk gravy
Toast	Green onions	Creamed lima beans
Butter	Banana and nut salad	Pineapple sauce
Milk	Bread	Celery
	Butter	Bread
	Milk	Butter
		Milk

These foods contain protein, sugar, starch, fat, minerals, and vitamins, and are foods which you will enjoy eating. It is necessary that those who supply food for institutions, or for the army and navy, should choose those which contain all the food substances that the body needs.

QUESTIONS

What is the least cost of a pound of sugar? of starch? of fat? of protein?

Name the principal food groups.

What are *cereals?*

What food elements do cereal foods contain?

What is *light* bread?

Why cannot corn meal alone be made into light bread?

What food elements does white flour lack?

What food substances do fleshy vegetables contain?

For what class of persons are beans well suited?

What is the food value of peanuts?

What food substances are contained in potatoes?

Why does a person need to eat garden vegetables?

How may scurvy be prevented?

What food substances does fruit contain?

How do dried fruits compare with the fresh fruits in food value?

Compare animal foods with vegetable foods.

What food substances are found in meat?

What is the principal difference between the expensive kinds of meat and the cheaper kinds?

What food value has beef tea?

How does fish compare with meat in food value?

What is the difference in food value between shellfish and meat?

What food substances are found in eggs?

What food substances are found in milk?

Why is milk one of the most valuable of all foods for children?

How much milk would a man doing hard work need to drink if he took no other food?

What is the food value of cream? of skim milk? of buttermilk? of butter?

Of what food elements does cheese consist?

Why are coffee and tea called stimulants, and not foods?

What substance in tea and coffee is a stimulant?

Why is cocoa a better drink for children than tea and coffee?

Write out a day's bill of fare (different from the one in this book) which contains all the food elements that the body needs.

For the Teacher. — The topics in this chapter lead up to the practical one of choosing menus. It is practical and scientific to divide foods into the four groups which are mentioned in the text. A menu is likely to afford a balanced diet if in the course of a day it contains a food from each group.

Experiments on lower animals and experience in feeding children show that the food substances which are lacking the most often are the vitamins and minerals that are found in milk, fresh vegetables, and fruit. Under the conditions which exist in most American homes a practical rule is to eat the following substances in the course of a day:

1. Milk, either alone or in cooked dishes, one quart daily.
2. Raw fruit, or salads, or greens; a goodly helping in at least one meal each day.
3. Any other foods that satisfy the taste and appetite.

Have the pupils write out the names and amounts of the food which they ate for a certain day. Discuss the menus from the standpoint of balanced diets.

The question of vegetarianism is often brought up. It is possible for adults to live healthy, vigorous lives when they eat no animal food, but it is doubtful if children can do so. Most so-called vegetarians use milk, which is an animal food, and many use eggs also. It is true that most Americans eat much more meat than they need.

The cost of food is not a true indication of its food value, as is shown by the tables on page 277. Cereals bought ready for the table cost at least five times as much as oatmeal, but are no more nourishing. Desserts are far more costly than their constituent food substances would be if they were plainly cooked.

CHAPTER XXIV

WHOLESOME FOOD

Storing Food. — Fruit, meat, and many other foods which naturally decay within a few days may be preserved for a long time if proper care is taken to prevent bacteria and molds from growing in them. Three ways of preserving foods in large quantities are by canning them, by drying them, and by putting them in cold storage.

Canned Foods. — Cooked foods will remain fresh for years if they are properly canned, for they are then protected from bacteria and molds (p. 43). If food is fresh, and is properly canned, it will retain its appearance and wholesomeness for years without the addition of preservatives.

Drying Food. — Fruits, vegetables, and meat will remain free from bacteria and molds, and will keep fresh, if they are dried and are then stored in a dry place. Food that has been properly dried and stored has almost the same food value that it had while it was fresh, except that the amount of vitamins is sometimes lessened. Dried apples are cheap and may be bought at any season of the year; and, when cooked,

they have nearly the same food value that they would have had if they had been cooked while they were fresh. One reason why dried fruit may sometimes have less food value than fresh fruit is that the best fruit is usually sold fresh, and the poorer fruit is dried.

Cold Storage. — Large quantities of meat, fish, eggs, and other food are preserved fresh for many months by being stored in rooms which are kept at about a freezing temperature. The cold prevents the growth of bacteria and molds, and also prevents other changes which would naturally take place in the food. The principal objects of cold storage are to preserve a food while it is taken long distances to market, and to store it safely while it is abundant in order that it may be used when a new supply of the food cannot be obtained. The meat and fish which are used in large cities usually come to market in cold storage cars, and are kept in cold storage until they are used. It would be almost impossible to supply a large city with food without cold storage.

All kinds of food that are not injured by cold may be preserved in cold storage. If a food is poor in quality, or is spoiled when it is placed in cold storage, it will be in the same, or a worse, state when it is taken out. If it is fresh and wholesome when it is placed in cold storage, it will remain wholesome for months.

Keeping Food Fresh. — Many kinds of food, such as meat, milk, and cooked foods, usually turn sour or spoil within a very few days after they are brought

into the kitchen, or prepared for the table, unless great pains are taken to keep them fresh. Food will not decay or turn sour if no bacteria or molds grow in it (p. 43). There are three principal ways of keeping food from spoiling in a kitchen or pantry:

1. Food will not decay if it is kept dry, for bacteria will not grow without water. For this reason dry crackers will keep longer than bread, and dried beef will keep longer than fresh meat. Storing food in a dry place is a great help in keeping it fresh.

2. Food will not spoil if it is kept cold, for bacteria grow very slowly in cold places. Frozen meat will not spoil at all, but freezing will injure most vegetables and fruit. A cold cellar or an ice box is a great help in keeping food fresh.

3. If food is clean, it will have very few bacteria in it, and will keep fresh for a long time. Clean hands, clean dishes, a clean pantry, and keeping flies away from food, are all great helps in keeping food from spoiling.

Sour Milk. — Milk spoils and turns sour more readily than most other common foods. The souring is caused by bacteria which fall into the milk with dust and dirt. Some kinds of bacteria growing in milk produce a sour substance called *lactic acid*, which curdles the protein of the milk and makes it like jelly. The bacteria which turn milk sour are not usually harmful to grown persons, and do not spoil the milk for cooking. But any milk that is about to turn sour, or that con-

tains many bacteria, is dangerous for children and babies, for it usually contains bacteria that produce sickness.

Milk which contains harmful bacteria causes over a quarter of all deaths among babies. Nearly all intestinal diseases among young children are due to unclean milk. Babies are more likely to have these diseases in summer than in winter, because most milk spoils quickly during warm weather, unless it is kept cool.

A Sanitary Cow Barn

Wholesome milk is produced by clean cows in clean stables.

Wholesome Milk. — Wholesome milk means milk which is clean and almost free from bacteria. The dirt in milk comes from dirty cows, dirty stables, and the dirty clothes and hands of the milkmen. Many farmers object to sweeping and scrubbing the cow stables, currying and brushing the cows, washing the hands, and putting on clean clothes before milking, and carrying the milk at once to clean rooms. But these things must be done if milk is to be wholesome. What is called *certified milk* is pure because it is produced in this cleanly way. It is almost the only milk which may be safely fed to babies without first doing something to it to kill the germs.

Some persons suppose that the harmful dirt may be strained from milk. This is not so. Thousands of bacteria will be washed off from every speck of dirt as large as a grain of sand, and there is no way of removing them from the milk. If there is any dirt at all in the bottom of a milk pail or pitcher, or on the strainer, that milk is sure to be loaded with bacteria. It will not keep well, and will not be fit to be fed to small children, unless the bacteria in it are killed before they have time to grow and spoil the milk.

THE SMELLING TEST FOR THE CLEANLINESS OF A MILK PAIL

An unpleasant odor in a milk can or pail, after it has been covered for half an hour, shows that it is dirty.

Dirt often falls into milk while it is being handled in open cans. The cleanest way of carrying milk to market is to place it in clean bottles as soon as it is milked, and then to seal the bottles, so that no dirt can get into them.

Buy your milk from a man who has clean stables, clean cows, clean milk cans, clean hands, and clean clothes. Put it in a clean pail or pitcher, and keep it in a clean place, and away from flies. Choose bottled milk, if possible.

Bad tastes in milk usually come either from dirt that falls into it, or from dirty pails and pitchers. Dried

milk left in the seams or on the sides of a milk can will decay and give off bad odors. When milk is put into the can, the bacteria of the decay grow in the milk and produce unpleasant odors and tastes. A test for the cleanliness of a milk can is to cover it tight for half an hour, and then remove the cover and smell of the inside of the can before the odors can escape. If there is an unpleasant odor, the can is dirty and the milk which is put into it will have the same odor and taste.

A Sanitary Milk Room

Wholesome milk is handled in a clean milk room and in clean utensils. This man is putting seal caps on the bottles.

Cooling Milk. — The number of bacteria in each drop of ordinary milk is several thousand while it is fresh, and is often many million after it has stood for a few hours in a warm room. The cleanest milk that can be bought or produced will have a few hundred bacteria in each drop. These will not usually do harm if they do not increase in number.

The easiest way to keep bacteria from growing is to cool the milk, for they will hardly grow at all if the milk is kept as cold as water in an ordinary well. Those who produce wholesome milk cool it as soon as it is milked, and keep it cool until it is

sold. Buy such milk if possible, and keep it in a cellar, or ice box, or other cool place.

ICING CERTIFIED MILK

Wholesome milk is kept cold.

Pasteurizing Milk. — Heating milk boiling hot will kill all the germs that may be in it. This is called *ster'-ilizing* it. But a boiling heat changes its taste.

Heating milk to 145° F. and holding it at that temperature for thirty minutes will kill the bacteria and disease germs which may be in the milk. This process is called *pasteuriza'tion.* The heat does not change the taste or the digestibility of the milk. Pasteurized milk is a safe food for babies, if the milk is fresh when it is heated, and is afterwards kept cool and clean.

Food Sold on the Streets. — Food which is sold from carts, or is placed in front of stores for show, often becomes soiled with dust and dirt from the street, and by flies which light upon it, and by the dirty hands of those who handle it. In all of these ways disease germs are often left upon food which is kept in front of stores. Food bought in these places may not be safe unless it is afterwards cooked so that the disease germs which

may be on it will be killed. Boards of health often require that foods offered for sale shall be kept covered.

Adulterated Food. — Some foods which appear to be pure contain substances which are added to lessen the cost or to make poor goods appear to be of good quality. These foods are called *adul'terated.* Milk is sometimes adulterated with water, coffee with chicory root, and olive oil with cottonseed oil. Benzoate of soda is often added to catchup of poor quality in order to preserve it.

A great many medicines which are advertised as harmless contain harmful drugs. Many pain killers and soothing sirups contain opium, and headache cures contain substances, such as phenacetin (fė-năs'ė-tĭn), which produce dangerous weakness of the heart.

Pure Food Laws. — Deceiving people by selling adulterated foods and harmful drugs is a crime. Many countries and states have laws that all packages of foods and drugs that are sold shall be marked with a list of the substances which they contain. The object of such laws is to enable those who buy the goods to know what kind of articles they are buying.

Food Poisoning. — Poisoning by food may be caused by three conditions in the food:

1. Decay, souring, fermentation, or spoiling.

2. A disease in an animal from which meat or milk is taken.

3. Human disease germs which have been put into the food by persons who handle it.

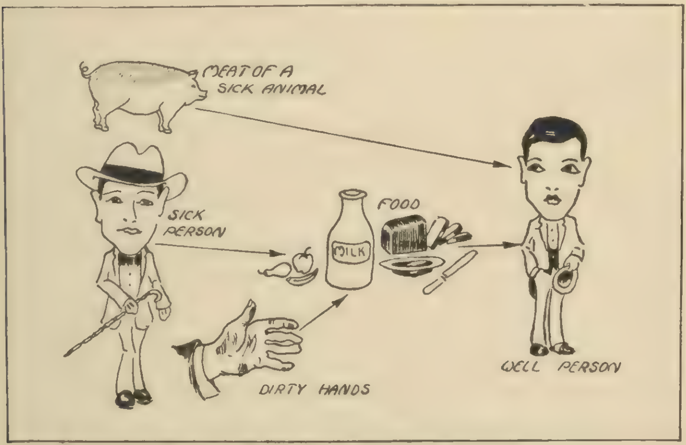
Spoiled Food. — Ordinary decay or spoiling does not make food harmful or poisonous so often as was formerly thought. The processes of souring or fermentation are used in making certain foods, as butter, sauerkraut, and cheese; the outer parts of wholesome meat are often decayed; and farmers handle decayed substances safely as they use them for fertilizers. But there are a few kinds of bacteria which may produce dangerous poisons when they grow in food. One kind of poisoning is called *botulism* (bŏt′ū-lĭz'm). The poisons of this sickness are formed by bacteria which usually produce offensive odors and tastes in the food in which they grow. They are found principally in canned goods which have not been heated sufficiently to kill the germs. A bad odor or taste of a can of food is a sign that the food may be dangerous to use.

Meat of Diseased Animals. — Some diseases of lower animals may be transmitted to persons. The milk of a cow that has tuberculosis may contain living bacteria which may cause tuberculosis in a person who drinks the milk.

There are some diseases which cause the flesh of animals to be poisonous to persons, although the germs of the disease may not grow in a person. Hog cholera is a disease of hogs which is something like measles in a person, and the meat of an animal that has the disease may be poisonous to man. The laws of some states forbid the sale of the meat of an animal that

is thin or sick unless it is first inspected by a skilled veterinarian and all diseased meat is destroyed.

Disease Germs in Food. — A third form of food poisoning is that caused by human disease germs which come from diseased persons or carriers. Some common diseases which are spread by means of food are typhoid



WHY FOODS BECOME POISONOUS

The poisons usually come from the dirty hands or the nose or mouth of a person who handles the food, or from the meat of a sick animal.

fever, scarlet fever, diphtheria, and a form of tonsillitis called *streptococ'cus sore throat.*

The principal sources of disease germs in food are:

1. Diseased persons or carriers who handle food.
2. Impure water used in preparing food.
3. Flies.

If a food causes a disease, the principal reason usually is that some diseased person or carrier has put the

germs in the food while handling it. A food handler infects food by means of soiled fingers, or by sneezing or coughing upon the food. Some cities have laws that food handlers in eating houses shall be examined, and that no diseased person or carrier shall be allowed to work in kitchens, or to handle food that is to be eaten raw.

Milk is the principal food which may carry disease germs, for it is a liquid, and germs may be scattered through it readily and be carried to hundreds of people along a milk route. The germs may also grow and multiply in milk more readily than in any other food. The great reason for pasteurizing milk is to kill the disease germs which may be in it. The heat of good cooking will kill most disease germs that are in food.

Good Cooking. — Most kinds of food are more wholesome when they are well cooked than when they are poorly cooked or raw. Very few kinds are made less digestible by long cooking. Most foods made from grain cannot be digested readily unless they have been cooked for at least an hour or two. Oatmeal may be soft and may taste good after it has been cooked for only fifteen minutes, but it will not be readily digested unless it has been cooked for some hours. A good way of preparing it for breakfast is to put it on to boil in the evening, and let it cook slowly all night.

Stews. — When meat is cooked, some of its juices and fat run out. If the liquid is thrown away, much of the nourishment and a great deal of the best tasting

parts of the meat are wasted. A good way of cooking meat is to make it into a stew or thick soup with potatoes and vegetables. This method saves all the nourishment that is in the raw food.

Another good way to cook meat is to place it in a hot oven for a few moments so that a crust will form over it quickly and prevent the juices from escaping. Then allow the oven to cool a little, so that the meat will cook slowly without burning.

Desserts. — Pie, cake, and pudding are cooked mixtures of flour, sugar, fat, eggs, and fruit, and are usually hard to digest. A person would soon get tired of them if he had to live on them alone. Their food value is that of the flour, eggs, and other things of which they are made.

QUESTIONS

What is the cause of the spoiling of food?

How does dryness help to preserve food from spoiling?

How does a low temperature help to preserve food from spoiling?

How does cleanliness help to preserve food from spoiling?

Why do foods remain fresh when they are properly canned?

How does drying affect the food value of fruit and vegetables?

When food is properly kept in cold storage rooms, how is its food value affected?

Name three ways in which food may be kept fresh in a kitchen or pantry.

What is the cause of the souring of milk?

What is meant by *wholesome milk?*

Where do the bacteria that are in milk come from?

How may milk be produced almost free from bacteria?

Why is bottled milk usually more wholesome than milk sold from large cans?

Why is cold milk more likely to remain wholesome than warm milk?

How is milk *pasteurized?*

Why is pasteurized milk usually more wholesome for babies than raw milk?

Why is food that is sold from stands on the streets likely to be unwholesome?

What is an *adulterated* food?

What is the object of pure food laws?

What effect does good cooking have on food?

What effect has long cooking on the digestibility of vegetable foods?

Why is a stew one of the most nourishing forms of cooked meat?

Describe some forms of food poisoning.

Why should a diseased person not be allowed to handle food?

What effect does cooking have on disease germs that are in food?

For the Teacher. — How to keep food fresh and wholesome is one of the greatest problems with which city dwellers have to deal; but the topic is also important to rural people.

Food properly kept in cold storage comes out of the storage as good as it went in.

The possible loss of vitamins is not a sufficient reason for neglecting to use foods which have been canned or dried, for the missing vitamins may be easily supplied by the use of additional articles of food.

The preservation of milk depends on two conditions, — cleanliness and cold. These two conditions must exist in the home as well as in the dairy, if milk is to be kept wholesome. If possible, take the pupils to a good dairy and show them how clean, wholesome milk is produced. Also demonstrate the odor test for the cleanliness of a milk pail. This same odor test is excellent for testing the cleanliness of table dishes after they have been washed.

Milk handled by a diseased person is likely to spread his disease. Scarlet fever and diphtheria are frequently spread by a dairy workman who is only slightly sick. A person who has a cold, or sore throat, or diarrhœa, has no right to endanger the life or health of other persons by handling milk which is to be used by others.

While any food which has become soured or otherwise spoiled may be unwholesome, it is seldom the cause of diarrhœa or other form of food poisoning. Emphasize the danger of food poisoning by means of the meat of sick animals, or by means of disease germs left upon the food by persons who are sick or carry the disease germs on their unclean hands.

CHAPTER XXV

CARE OF THE NOSE AND MOUTH

Focal Infections. — Disease germs may grow in a small part of the body and produce little harm in that spot, and at the same time their poisons may pass through the body and cause a severe sickness. A growth of disease germs continuing for months or years in a small part of the body is called a *focal infection.*

The diseases which are caused by focal infections usually come on slowly, vary from day to day, and produce discomfort and weakness without confining the sick person to his bed. Three common diseases often caused by focal infections are:

1. Rheumatism in its various forms.
2. Heart disease.
3. Chorea, or St. Vitus's Dance.

The principal causes of the pains and aches which are often called rheumatism are focal infections, especially of the tonsils and teeth. There is no cure for rheumatism as long as the focal infections which cause it are allowed to continue. The first step in the treatment of rheumatism is to discover and remove the focal infection which causes it.

The parts of the body in which focal infections often occur are:

1. The tonsils.
2. The nose.
3. The mouth.
4. The teeth.

Bacteria in the Tonsils. — If the tonsils are enlarged, they nearly always contain numbers of deep holes and pockets (p. 144). These holes may become filled with mucus, dead epithelium, and bits of food. Bacteria may lie in them undisturbed and cause the contents of the holes to decay. Disease germs also may lodge in them and produce tonsillitis and other forms of sore throat. On the other hand, disease germs may grow continuously in the holes without producing soreness of the throat, and yet they may form a focal infection which produces rheumatism and heart disease. White spots about the size of pinheads may sometimes be seen on the tonsils. The spots are the outer ends of masses of decaying substances, pus, and disease germs which fill the holes. Tonsils which are full of holes or contain white spots are dangerous to health, and should be removed by a surgeon.

Bacteria in the Nose. — Bacteria may always be found growing in the nose. If its air tubes are large and open, the mucus washes most of the bacteria away and prevents them from becoming great in number, or doing harm. But if the air tubes are stopped up, bacteria and disease germs may grow in the nose and produce a cold, or sore throat, or pneumonia.

Cleansing the Nose. — Cleansing the nose and keep-

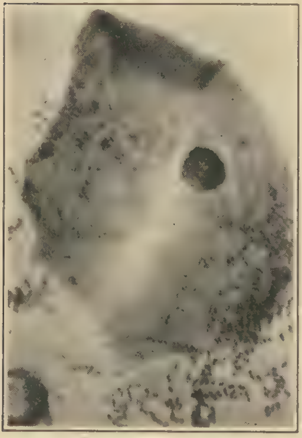
ing its tubes open are necessary for health. This can usually be done by blowing the nose, for the mucus in the nose is its natural bath which washes away dirt and disease germs as fast as they are formed. Therefore a clean handkerchief is a very necessary thing for every man, woman, and child to carry and to use.

The nose may be stopped up by a swelling of its lining, or a crooked bone in the nostril. If this is so, trying to blow the nose will make the stoppage worse. If your nose is stopped up and you cannot open it by blowing it lightly after holding your breath (p. 142), go to a doctor and have it examined and treated.

The bones which surround the nostrils are partly hollow and contain cavities, called *sinuses* (sī′nus-ĕz), which are as large as the nostrils themselves. There is a large sinus, called the *an′trum*, on each upper jaw-bone under the eye, and another, called the *frontal sinus*, behind each eyebrow. These cavities open into the nose, and are really a part of it. If a person has a cold, disease germs may enter a sinus and cause it to become filled with thick mucus. The sinus may then become the site of a focal infection which makes the whole body weak and sick. A person who has a cold in the head for weeks and blows much mucus from the nose probably has sinus disease and needs to be treated by a skilled physician.

Bacteria in the Mouth. — The mouth is warm and moist, and contains many substances on which bacteria may live. Many kinds of bacteria are always

growing on the tongue and cheeks and between the teeth. The bacteria often produce decay and bad odors. Disease germs also often enter the mouth and grow there. Cleansing the mouth is very necessary for health. Washing the mouth with water will cleanse it. Merely rinsing the mouth with water will not wash away thick mucus or the coating from the tongue. When you brush your teeth, cleanse your whole mouth by rubbing the toothbrush over the tongue and the roof of the mouth.



BACTERIA AND AN EPITHELIAL CELL FROM THE MOUTH

(Magnified 2000 times.) Bacteria are the cause of a bad odor in the breath, and of much of the coating on the tongue.

Bacteria in the Teeth. — Bacteria which produce decay and disease often grow in the teeth and gums. The teeth are more likely to become unsound and diseased than any other part of the body. Three common diseases of the teeth and gums are:

1. Decay of the substance of a tooth.
2. Abscess in the bone around a tooth.
3. Abscess and soreness of the gums around a tooth.

Decay of Teeth. — A tooth is composed of a kind of hard bone, called *dentine* (dĕn′tĭn), which is covered with a thin layer of a harder substance, called *enam′el.* The center of each tooth has a hollow space containing

nerves and blood tubes. The tooth is fixed in the bone of the jaw with a kind of soft bone, called *cement*.

Teeth are likely to decay unless they receive great care. The decay is caused by bacteria which grow in the teeth. Sound enamel is like the epithelium on the skin, and prevents bacteria from entering a tooth. But if the enamel is unsound or injured, bacteria may pass through it and cause the dentine to decay and go to pieces. If the decayed part reaches a nerve, the tooth may ache.

A DECAYED TOOTH

A decayed tooth is like an open sore through which disease germs may enter the body.

If babies do not get the proper minerals in their food, their teeth do not form a sound enamel, and are likely to decay early. If a young child has a whole row of front teeth decayed, that child will usually be found to have been fed on condensed milk or other incomplete food while the teeth were growing.

When a tooth has a hole in it, any bacteria which may be in the mouth may lodge in the hole and grow there. Persons sometimes catch diphtheria, tonsillitis, and tuberculosis because a few germs of these diseases have lodged in a decayed tooth and multiplied there.

The two principal means of caring for teeth are:

1. Brushing them.
2. Having them filled.

Brushing the Teeth. — Brushing the teeth removes dirt and bacteria from them and helps to prevent them and the gums from becoming diseased. Cleanse your teeth with a toothbrush and water two or three times a day. Brush their inner surfaces as well as their front sides, and brush the back teeth as well as the front ones. Rub the brush up and down as well as sidewise, so that the bristles will reach between the teeth.

A tooth powder or paste is useful in cleansing the teeth when you brush them. Many tooth powders contain powdered chalk, which helps to destroy harmful acids in the mouth. A soap which has no taste is also useful in cleansing the teeth and mouth.

Particles of food may become wedged between the teeth so tightly that a toothbrush will not remove them. Push them from between the teeth with a toothpick made of soft wood, for a toothpick made of metal or hard wood may crack the enamel and start a hole in the tooth. You may also remove food and dirt from between the teeth by passing a thread between them.

Filling Teeth. — You may save a decaying tooth by having a dentist remove the decayed part and fill the hole with a cement or a metal. The filling will close the hole and prevent bacteria from entering the tooth. Have a dentist examine your teeth every few months, and fill each hole as soon as it appears. In this way you can preserve your teeth for a lifetime, and prevent the ill health that comes from poor teeth.

Diseased Gums. — When dirt is allowed to remain in

the mouth and on the teeth, bacteria often grow between the gums and the teeth. The bacteria may slowly loosen the flesh from the teeth and bone until the gums form pockets in which dirt and disease germs collect. If the gums are healthy, their thin edges will cling closely to the necks of the teeth. But if the gums are diseased, their edges will be thickened and will hang away from the teeth, and the roots of the teeth will be bare up to the bone of the jaw. Disease germs may collect in the pockets of the gums, and may be a source of focal infection which produces sickness of the whole body.

A common cause of disease of the gums is a dark-colored, mineral substance, called *tar′tar*, which collects at the roots of unclean teeth and pushes away the gums. Brushing the teeth regularly every day helps to prevent the tartar from forming; but it may be necessary to have a dentist scrape the tartar away every few months.

Abscess of the Roots of Teeth. — Bacteria which grow in the gums around the teeth may extend down the cement and cause the teeth to become loosened and abscesses to form in the bone around the teeth. Bacteria may also pass down through the center of a decayed tooth and cause an abscess to form in the bone around the deepest part of the root of the tooth. The abscesses may be a source of focal infection which produces rheumatism and heart disease. The abscesses sometimes produce severe pain which drives a person to a dentist for relief. But often they are neither painful nor

tender. A person may not be aware that he has trouble with his teeth, and yet they may be the cause of severe attacks of rheumatism and other forms of sickness. If a person suffers from rheumatism or heart disease, one of the first things to do is to have an X-ray examination of the teeth made to see if they have abscesses around their roots. If the teeth are found diseased, they must be cured before the sickness of the rest of the body can be cured.

AN X-RAY PICTURE OF TEETH
a, abscess in the bone around a tooth; *b*, metal filling; *c*, metal cap.

Care of the First Set of Teeth. — Two sets of teeth grow in the mouth during a lifetime. Those of the first set begin to drop out when a child is about six years old, and new ones grow in their places. The last of the first set are not replaced until the child is twelve or fourteen years old.

The teeth of the first set are as likely to decay and produce sickness as those of the second set. Holes in those of the first set are as painful and as harmful to health as holes in those of the second set. Many children suffer for ten years or more with toothache and rheumatism while they are waiting for new teeth to grow in the places of those which are decayed or have abscesses at their roots. Brushing, filling, and treating the teeth of a three-year-old child are as necessary as the care of the teeth of its parents. Many schools employ

dentists to examine and treat the teeth of the pupils in order to protect them from diseases which come from focal infections.

Sixth-year Molar. — In the first set of teeth there are only two double teeth on each side of each jaw. A third double tooth appears behind the two when a child is about six years old. This tooth is the first one of the second set, and is called the *sixth-year molar*. Many persons do not take care of it because they suppose that it is one of the first set, and that another tooth will take its place. This tooth is the largest and most useful of all the double teeth, and if it is lost, no other tooth will grow in its place. Watch it, and have it filled as soon as it shows signs of decay.

SIXTH-YEAR MOLAR

The teeth of an eight-year-old child. The tooth on each end is the sixth-year molar.

QUESTIONS

What is a *focal infection?*
How may diseased teeth or tonsils produce rheumatism?
How can you recognize diseased tonsils?
Of what use is the mucus which is produced in the nose?
How may the nose be cleansed?
How may the use of a handkerchief affect the health of the body?
What is *sinus* disease?
How can you cleanse your mouth?
Name three common diseases of the teeth and gums.
Describe a tooth.
What are some of the causes of decayed teeth?
How may decayed teeth help to produce diseases?
Why should the teeth be brushed every day?

Why should teeth be filled?

What are some of the signs of diseased gums?

How may diseased gums be prevented?

What is a danger from abscesses of the roots of teeth?

How may pain in a tooth be a protection to the rest of the body?

What is a *sixth-year molar?* Why should it be given great care?

For the Teacher. — The nose and throat are of sufficient importance and prominence to justify great efforts to keep them clean and in a healthy, attractive condition; but a greater reason for their care is that of preventing heart disease, chorea, and so-called rheumatism, for all these diseases are usually caused by focal infections in the nose or mouth.

Teach the pupils the necessity of cleansing the nose by blowing it. Inspect their handkerchiefs to see that they are clean.

Also impress the pupils with the necessity of cleansing the tongue whenever they brush their teeth. The coating on the tongue may be the cause as well as the result of sickness.

Cavities in decayed teeth may harbor disease germs; but a greater breeding place of disease germs is under diseased gums and around the roots of the teeth. A slow abscess may start between the gum and a tooth and travel along the root until the tooth is loose. This condition is called Rigg's Disease, and may usually be prevented by the proper use of a toothbrush. The only proper treatment for an abscess deep around the root of a tooth is to have the tooth pulled out.

A tendency to decay in teeth is the result of improper food while a person is very young and the teeth are forming. Experiments in feeding animals, such as squirrels, in which the front teeth grow continuously during life, show that a tooth will be soft in the section which grows while improper food is given, and hard in the section which grows while the food is proper. The soft sections decay like soft human teeth. Tooth substance which is formed while the food is improper is like a section of concrete which is made from poor cement.

Emphasize the danger from infected tonsils and the need of having them removed. White spots on a tonsil are sure indications of disease.

CHAPTER XXVI

INFECTIOUS DISEASES

Cause of Infectious Diseases. — Those forms of sickness that are caused by living germs growing in the body are called *infectious diseases* (p. 37). Some of the common infectious diseases are colds, measles, scarlet fever, diphtheria, typhoid fever, whooping cough, tuberculosis, tonsillitis, and pneumonia. Each disease is caused by a particular kind of germ which is different from the germs of all other diseases.

A person will not have an infectious disease unless the germs of that disease enter his body. Catching a disease means taking its germs into the body. Taking disease germs into the body is called *infection.*

Cultures. — The germs of most diseases may be grown in glass tubes or dishes outside of the human body when they are planted in the proper substances. An artificial growth of disease germs outside of the body is called a *cul'ture.* Physicians often make cultures of germs taken from sick persons in order to discover the kind of disease germs which are causing the sickness. When a physician makes a culture, he takes some of the blood or waste matter from the sick person and plants it in a tube in order that the disease germs may grow and

multiply until they may readily be seen and studied. Boards of health require that cultures shall be made in all cases in which diphtheria may be suspected.

A CULTURE TUBE

The substance in the tube consists mainly of the serum of beef blood, and is an excellent soil on which disease germs grow when they are removed from the body and planted in the tube.

Conditions for Spreading a Disease. — In order that a disease may spread, four events must occur:

1. Its germs must grow in the body of a person or lower animal.

2. The germs must be given off from the body.

3. They must travel to another person.

4. They must grow and multiply in this person's body.

Source of Disease Germs. — Germs of an infectious disease nearly always come only from some person or animal that has the disease. It is often said that they come from dirt, sewage, and decaying substances, but no

disease germ of any kind will be found in such things unless that kind of germ is first planted in them.

There are three classes of persons who produce disease germs:

1. Those who are severely sick.

2. Those who are mildly sick, or are beginning to be sick, or are nearly well.

3. Well persons who carry disease germs in their bodies without being sick.

Those who are severely sick stay at home and in bed. They cannot go to other persons to spread their disease germs to them; and other people know that they are sick, and fear to go near them. But those who are mildly sick often go among other people and do not think about the disease germs which they may be spreading. Most diseases are now spread by those who are mildly sick, and are ignorant of the danger which they are to others.

Carriers. — The germs of a few diseases may grow in a small part of a person's body without causing a sickness. A well person who has disease germs growing in his body is called a *carrier*. Two kinds of disease germs of which well persons are sometimes carriers are those of diphtheria and typhoid fever. When a number of children become sick with diphtheria in a school, the cause may usually be traced to a well person who is a carrier of diphtheria germs. A carrier of disease germs can spread a disease as readily as a person who is sick with the disease.

How Disease Germs Leave the Body. — Disease germs leave the body of a sick person or a carrier in five ways. The four principal ways are through the intestine, kidneys, nose, and mouth. These are also the principal gateways through which excretions leave the body (p. 198). Nearly every excretion from the body of a diseased person may contain germs of the disease (p. 201). If all excretions from the sick were destroyed, few kinds of disease germs could reach other persons to infect them.

Disease Germs and the Skin. — The fifth way in which disease germs pass off from the body is through sores or other openings on the skin. Disease germs cannot pass through healthy epithelium (p. 186), but they may pass from spots on which the epithelium is destroyed. Smallpox and chicken pox are two diseases whose germs leave the body through sores on the skin.

Biting insects may pierce healthy epithelium with their bills and take up disease germs with the blood which they suck, and may inject the germs into the next person whom they bite. Malaria is a common disease which is spread by means of the bites of mosquitoes (p. 232).

The healthy skin of any person may indirectly be the means of spreading diseases when it is soiled with the excretions of the body (p. 201).

Disease Germs and the Air. — Disease germs do not pass off from the body with the breath during quiet breathing. But when a person coughs, or sneezes, or

blows his nose, or spits, he usually expels little drops of mucus and saliva, and these may contain disease germs. If the drops are blown upon the face of another person that person is likely to take living germs of the disease into his body. Infection by means of tiny drops of excretion blown from the nose and throat is one of the most common ways of spreading diseases. Five feet is about as far as the drops usually float, for they are heavier than air and soon fall to the ground.

Disease germs may rise with dust, if the floor of a room contains saliva and other excretions from a diseased person. Most foul air is dusty, and often contains disease germs which have risen with the dust.

It is almost impossible to find disease germs in the outdoor air, even a few feet from a person who has an infectious disease, or near a house in which he is sick.

For the effects of bad weather see page 178.

Routes of Infection. — After disease germs have left the body of a sick person, they must travel to another person and enter his body before they can produce a disease. In order to understand how disease germs pass from the sick to the well, one must remember the following facts:

1. Disease germs outside of the body are found in company with excretions from the bodies of the sick.
2. They rarely grow and multiply outside of the body, except now and then in milk and other food.
3. They usually die in a few hours or days, and often in a few minutes after they leave the body.

4. They usually travel from sick persons to the well by the short, direct routes by which excretions are carried from one person to another.

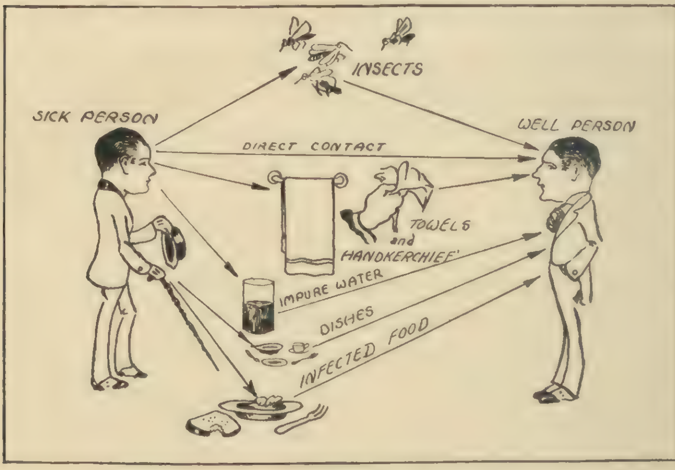


Diagram of Common Routes of Infection

The principal means by which disease germs are carried from the sick to the well are:

1. Contact.
2. Dirt.
3. Impure water and food.
4. Flies and other vermin.

Contact Infection. — The shortest and most direct route by which disease germs pass from the sick to the well is that called *contact*, in which the sick persons themselves put their disease germs almost directly into the bodies of those who are near to them. When two per-

sons are near each other face to face, it is almost impossible to avoid blowing drops of mucus and saliva into each other's faces while talking, laughing, coughing, or sneezing. Disease germs are also carried directly to other persons by means of kissing, and holding children on one's lap. Diseases are spread by contact more often than by any other method.

It was formerly believed that any one who merely called on a sick person would be likely to carry away disease germs on his clothes, and so would endanger others even if he did not catch the disease himself. This belief is not true, unless the visitor is extremely dirty and careless. Disease germs do not fly through the air, or cling to clothes for a time and fly off again to attack another person. A visitor will seldom carry disease germs away from a sick room unless he catches the disease himself.

Disease Germs and Dirt. — A route of carrying infection, which is somewhat longer than the contact route, is that by means of articles which have been soiled with the excretions of sick persons. The germs will be on soiled handkerchiefs, towels, dishes, bedding, clothes, and toys which the sick persons have used. If these things are washed well or boiled, the germs on them will be killed.

Dirt and filth will often contain disease germs, but not always. There are usually no disease germs in fresh ashes, or in the clean sand of the seashore, or in the fresh dust of a flour mill, or in the mud of a mountain

brook. The kind of dirt in which they will be found is that which contains excretions from the bodies of sick persons or lower animals. Whatever is soiled with anything which comes from a diseased person's nose, mouth, intestine, or kidneys may contain germs of the disease. The principal reason for keeping the body and everything about it clean is to be free from disease germs.

Disease Germs in Water and Food. — A still longer route of carrying infection is that by means of impure water and food. Water that contains sewage may carry disease germs into the body. Food may contain disease germs when it is prepared with impure water, or when some one handles it with soiled hands, or sprays disease germs over it by coughing or sneezing.

Disease Germs and Vermin. — Disease germs often reach the body by means of flies and other vermin (see Chapter XIX).

How Disease Germs Enter the Body. — The two gateways through which the germs of most diseases enter the body are the nose and the mouth. None of the germs of the common infectious diseases can enter the body through a healthy skin, for the epidermis will keep them out if it is sound (p. 186). Diseased persons and their excretions may be handled with safety if there are no cuts, or scratches, or sores on the skin.

If the epidermis is injured or diseased, germs may pass through it and enter the blood and the lymph. This is the way in which the germs of pimples, boils, and sore wounds enter the flesh. Malaria and yellow fever

are caused by germs which are put into the blood by the bites of mosquitoes. Hydrophobia is caused by germs which are put into the flesh by the teeth of dogs or cats which have the disease.

Incubation Period. — Disease germs which enter the body usually do no harm until they have grown and multiplied to countless millions. They must grow for hours or days before they become numerous enough to produce sickness. The length of time between the entrance of the germs and the beginning of the sickness is called the *incubation period.* A common cold has an incubation period of about two days; scarlet fever, a week or less; and measles, two weeks.

Protection against Disease Germs. — Every person often takes disease germs into his body without catching a disease, for the body can destroy the germs if only a few enter it. About a thousand germs must enter the body at one time in order that any of them may be able to grow and produce a disease. The body destroys disease germs in two ways. First, the white blood cells seize the germs and destroy them (p. 96). Second, the liquid part of the blood contains substances which hinder, or prevent, the growth of the germs. Some persons have a larger quantity of these substances than others, and so they escape diseases which others catch. But nearly every person will catch a disease if he takes a great number of germs into his body at once.

Immunity. — An infectious sickness shows that the blood of the sick person lacked the defensive substances

when the germs entered his body. But after the disease germs have grown for a few days, the blood usually forms the protective substances in such quantities that they overcome the disease germs and end the sickness. The body may then continue to form the protective substances for weeks or a lifetime. A person cannot usually take measles a second time because he continues to produce the defensive substances after he recovers from the first attack. A person whose blood contains the defensive substances against the germs of a disease is *immune* to that disease.

There is a protective substance against each disease. That against measles will not prevent chicken pox, and that against typhoid fever gives no protection against pneumonia. Some persons have the substances which protect them from a number of diseases, but no one has them against all diseases.

Diphtheria Antitoxin. — An example of a protective substance which is formed by the blood is diphtheria antitoxin. The antitoxin will overcome the poisons which are produced by diphtheria germs. About half of all persons have the antitoxin in their blood, and are immune to diphtheria. If a person has diphtheria, his blood lacks antitoxin; but if the antitoxin is injected into his body, it will act as well as that which the body naturally forms.

The antitoxin which is used in treating diphtheria is produced by horses. Diphtheria germs are grown in a liquid, and a few drops of the liquid are injected into

a horse. The animal is made slightly sick, but soon recovers. A larger quantity of the liquid is then given, and is repeated once or twice a week in increasing amounts. In about three months, the horse can take a pint of the liquid without harm, for the injections cause the animal to form great quantities of antitoxin in its blood. The antitoxin which is used in treating diphtheria is the purified blood serum of a horse which has

DIPHTHERIA ANTITOXIN

The antitoxin is given under the skin by means of a hypodermic syringe.

been treated in this way. A horse will produce enough antitoxin every three months to cure hundreds of persons who have diphtheria.

Horses are also used for producing antitoxins and other protective substances against lockjaw, meningitis (mĕn-ĭn-jī′tĭs), pneumonia, an′thrax, and other diseases.

Vaccines. — Protective substances against a disease may be produced by the body when the germs of that disease in a dead or greatly weakened form are injected into the body. Producing immunity to a disease by means of injections of its germs is called *vaccination* (văk-sĭ-nā′shun). Injections of dead typhoid fever germs were given to every American soldier in the World

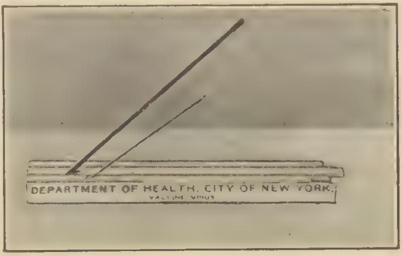
War, and as a result typhoid fever was almost unknown in the American army, although the disease had always been common in previous wars.

Vaccination for Smallpox. — Cows sometimes have a mild disease called *cowpox*. The germs of cowpox are like very weak germs of smallpox. When a person is vaccinated, a few of the germs from a calf are rubbed into a small scratch on his arm. The germs grow and cause a blister or sore to form on the spot. After two or three weeks the spot heals and leaves a scar. While the germs are growing in the flesh, they cause the blood to form a protective substance which will remain in the body, and will prevent smallpox germs from growing if they should enter the body. One vaccination will usually protect a person from smallpox for many years, and often for a lifetime. The vaccinated persons who do take the disease have it very mildly. A good rule is to vaccinate every child when he begins to go to school, and again at about the age of twelve.

Before the year 1800 smallpox was so common that everybody expected to have it, and more persons died from it than from any other disease. About that year vaccination was discovered by an English doctor named Edward Jen′ner, and was at once widely used. Since that time there has been less and less smallpox among civilized people. There is almost no smallpox in the city of New York, because the school children and most grown persons in that city are vaccinated.

Some persons refuse to be vaccinated because they fear

that the vaccination will produce a disease. If the arm is swollen, or if the vaccinated person is made sick, it is because dirt and disease germs were allowed to enter the vaccinated spot. Pure vaccine germs do not cause pain or sickness, and do not leave any harmful substance in the body. The vaccine that is now supplied by boards of health is pure, and is put up in sealed glass tubes. It is easy to put the vaccine into the arm in a clean and safe way. Disease germs may be kept out of a vaccination sore just as surely and readily as they may be kept out of drinking water, or out of a wound which a surgeon makes at an operation. If this is done, vaccination is safe, and does not produce any bad results.



SMALLPOX VACCINE

The vaccine is put up in small glass tubes whose ends are sealed by heat. A common sewing needle that can be passed through a flame for cleansing is used for making a tiny skin scratch on which the vaccine is planted.

QUESTIONS

What is the cause of infectious diseases?

Name some of the common infectious diseases.

What is a *culture?*

What is the great source of disease germs?

Where do disease germs which may be in dirt and sewage come from?

What is a *carrier?*

Why does a person mildly sick spread disease germs more readily than one who is dangerously sick?

Through what four natural gateways do disease germs leave the body of a sick person?

When may the skin give off disease germs?

When may the expired breath contain disease germs?

What is the source of disease germs in dusty air?

What are the principal means by which disease germs are carried from the sick to well persons?

What is *contact infection?*

Describe infection by means of toilet articles.

When may water or food contain disease germs?

What are the two gateways through which disease germs usually enter the body?

What disease germs usually enter the body through the skin?

What is meant by the *incubation period* of a disease?

By what two means does the body try to destroy disease germs which enter it?

What is *immunity?*

Describe *diphtheria antitoxin.*

Describe *typhoid vaccine.* What results followed its use in the army?

Describe *smallpox vaccine* and the manner by which it protects the body against smallpox.

What has been the effect of vaccine on the prevalence of smallpox?

For the Teacher. — The object of this chapter is to state the modern conception that every case of infectious disease is the result of disease germs which are introduced into the body from a previous case of the disease. This is in distinction from the old conception that the principal causes of infectious diseases were cold, dampness, and bad weather. When a disease develops, the modern health officer looks for the *person* from whom it was caught.

Emphasize the modern conception of a *carrier*, or a person in whom disease germs continue to grow after apparent recovery from a disease which may have been so mild that the existence of sickness was not suspected.

Develop the concept of the four common routes of the transmission of disease germs from one person to another by means of contact, dirt, impure water or food, and vermin.

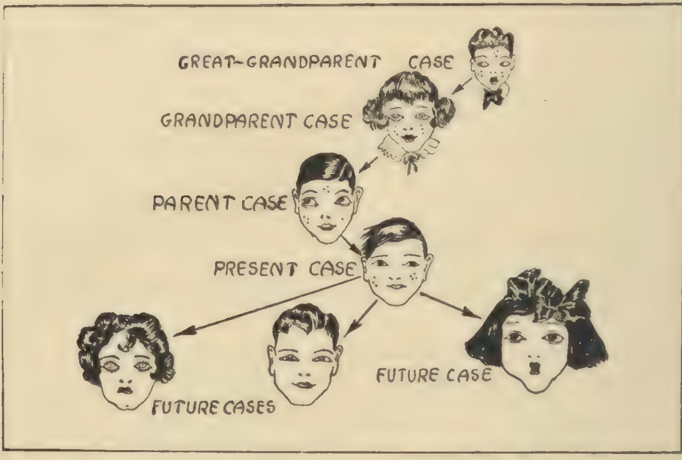
Develop the concept of the formation of protective substances, such as diphtheria antitoxin, which prevent disease germs from growing in the body. Also explain that the body can be induced to form the protective substances by the use of a vaccine, such as that against smallpox.

CHAPTER XXVII

PREVENTION OF INFECTIOUS DISEASES

Means of Prevention. — Nearly all infectious diseases may be prevented. Physicians and health officers know the source of disease germs, the routes by which they travel from the sick to the well, and the means of making the body immune to many diseases. But physicians and health officers cannot control diseases unless the people themselves have this knowledge, and also the willingness and desire to put themselves to some trouble in preventing their diseases from spreading to others. The control of infectious diseases is like the control of fires. Health departments put out the big epidemics of diseases, but only the people themselves can put out the little fires of infection before they become epidemics.

Finding Cases of Infectious Diseases. — In order to control the spread of diseases, the health officer must find the persons who are the sources of the disease germs. Every case of infectious disease comes from a parent case, and is preceded by an ancestral line of cases reaching back in time like a person's parents and



THE ANCESTRY OF A CASE OF INFECTIOUS DISEASE

Every case comes from a parent case, and that from a grandparent case, and so on back through a long line of sick persons.

grandparents. Any case may also have produced other cases, which are then like a person's children.

The first step in preventing the spread of a disease is to find all the sick persons who are producing the germs of the disease. If every such person were known and controlled, no other persons would catch the disease. The health officer finds the infected persons from two sources of information:

1. The reports of physicians who are called to treat the persons.

2. A search for cases which are not seen by physicians.

The laws of most states require every physician to inform the health officer or the board of health about the cases of infectious disease which he sees. Among

the common diseases which must be reported are chicken pox, diphtheria, measles, mumps, scarlet fever, tuberculosis, typhoid fever, and whooping cough.

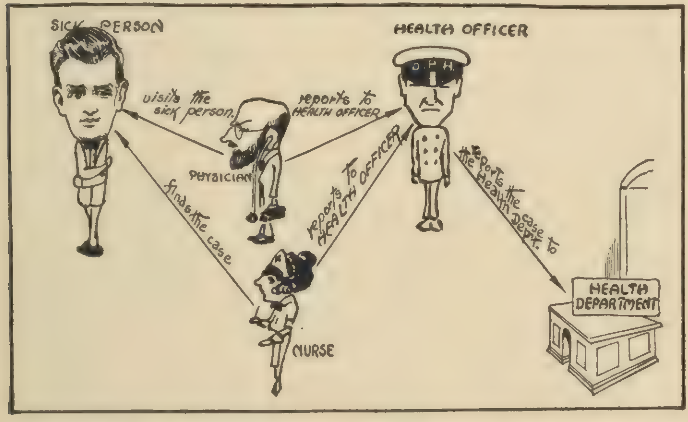


Diagram of Methods of Reporting a Case of Infectious Disease by a Physician and a Nurse

Many cases of infectious disease are mild, and those who see the sick do not recognize the disease, and do not call a physician or report the sickness to the health department. Most epidemics start from mild cases which have not been reported. When an infectious disease occurs in a town, the physicians and nurses of the department of health will search for such cases, and will visit the homes of children who are absent from school, and will call on persons whom they hear to be slightly ill. They often find many cases which have not been reported, because no doctor had been called.

Date of Onset. — When a health officer investigates

a case of infectious disease, he tries to find out its *date of onset*, which is the day on which the sick person showed or felt the first signs of illness. This date is important, because the sick person can usually give off the germs of his disease from the day of the beginning of his sickness. The health officer finds the date of onset by questioning the sick person or those who have been with him.

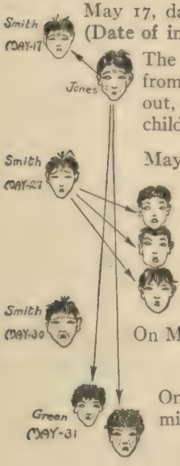
Finding Contacts. — Having found the date of onset, the health officer searches for the persons, called *contacts*, who have been with the sick person on and since that date, because some of these persons may have caught the disease. The contacts may be divided into two groups:

1. The immunes, or those who either have had the disease or have received an antitoxin, or vaccine, against it. These cannot take the disease, and nothing need be done with them.

2. Those not immune. These need to be watched during the incubation period of the disease (p. 321) in order to see whether or not they come down with the disease.

Finding the Source of Infection. — After a health officer has found the date of onset of a person's disease, he counts backward from it for the time of the incubation period of the disease in order to find the date of exposure, which is the date on which the disease was caught. The health officer then tries to find out where the sick person had been at that time, with whom

he had been in contact, and what he had been doing. In this way he is often able to find the source of the disease. Sometimes he finds it to be either a carrier



May 17, date on which the Smith child probably caught the measles. (Date of infection.)

The Jones child was found by the nurse to have been absent from school for three days about this time, with a slight breaking out, and to have played with the Smith child and the Green children.

May 27, the Smith boy first felt sick. (Date of onset.)

Three Brown children, contacts with Smith child on May 27, to be watched for two weeks to see if they have caught measles.

On May 30, the Smith boy, who has measles, first had a physician.

On May 31, two Green children are found by the nurse to be mildly sick with measles.

Diagram of the Results Found at an Investigation of a Case of Measles

The physician saw the Smith boy on May 30, and reported the case to the health officer. The nurse from the health department found that about May 17 the Smith boy had played with the Jones boy, who had measles in a mild form and had no doctor, and that two Green children were with them. A visit to the Green children showed that they too were sick with measles.

or a mild case that had not been reported, or the use of impure water or milk. If the source is either water or milk, several persons are usually made sick at the same time.

Means of Preventing the Spread of Diseases. — There are four principal methods of preventing the spread of diseases:

1. Controlling the persons who are the sources of disease germs.

2. Destroying germs as they leave the bodies of the sick.

3. Breaking up the routes by which the germs travel from the sick to the well.

4. Making the body immune to the germs which enter it.

Any one of these four means would stop the spread of almost any disease if it could be applied in a perfect manner, but the use of all four is usually necessary.

Control of Infected Persons. — The most direct route for the spread of disease is that by contact of the infected persons with those who are well (p. 318). When a health officer has found a case of infectious disease, he causes the infected person to remain away from other persons. There are three degrees of restraint which a health officer may impose; namely: 1, quarantine (kwŏr′an-tēn); 2, isolation; and 3, a lesser degree of restraint than either.

The most complete degree of restraint is that called *quarantine*, by which the sick person and all the members of his family are compelled to stay in a house or yard, and no one is allowed to enter it, except the doctor and nurse. This was the old method, and was used in times when the cause of infectious diseases was supposed to be spirits or gases which passed off from the sick and attacked well persons in

some unknown way. It is now seldom used, except with extremely ignorant or careless people, who cannot be trusted to obey the health officer.

The modern method of controlling infected persons is that called *isolation.* It consists in keeping the infected persons apart from those who are not immune to the disease. A child with scarlet fever, for example, is kept in one part of a house or yard, and the other members of the family are allowed to go about as usual, except that contacts who are not immune must be watched and possibly isolated during the period of incubation of the disease. Isolation is a safe method among people who are well-informed and are willing to help in preventing the spread of a disease. It is used in measles, scarlet fever, pneumonia, and most other infectious diseases, especially in those in which coughing and sneezing occur.

Lesser degrees of restraint which a health officer may require of the infected persons are:

1. They shall not go to meetings or among crowds.

2. They shall not go near children.

3. They shall not work where they handle food.

4. They shall avoid spreading disease germs from the nose and mouth by spitting, coughing, or other means.

The degree of restraint which the health officer imposes will depend partly on the nature of the disease, and partly on the intelligence and character of the

infected person, and of the people among whom the infected person lives or goes.

Disinfection of Excretions. — A person spreads disease germs by means of his excretions. If all the liquid and solid excretions of an infected person were caught and destroyed as soon as they leave the body, that person could not spread diseases. This cannot always be done when a person is coughing and sneezing and producing a great deal of mucus in the nose and throat, and so quarantine or isolation is necessary in some diseases. But every person, whether he is quarantined or isolated or not, should take care of his excretions and destroy them. Destroying the disease germs in excretions is called *disinfec'tion.*

The principal methods of disinfection are the following:

1. Catching the discharges of the nose and throat on handkerchiefs and napkins (p. 202).

2. Killing the germs on clothes, toilet articles, and the skin by cleanliness, laundering, and bathing.

3. Disposing of sewage in a proper manner (p. 204).

4. Allowing plenty of sunlight in houses and rooms (p. 168).

If all these means are used in a sick room, no disease germs will be left there; and when the sick person gets well, the room will be safe for use if the room and furniture are given a good house cleaning, and if the bedding and all toilet articles which have been used in the room are well washed and cleaned.

Disinfectants. — Substances, called *disinfect'ants*, are sometimes used in order to kill disease germs. Some common disinfectants are formalin and chloride of lime. They are of special value in the sick room where disease germs must be destroyed quickly.

It was formerly the custom to fumigate a sick room with a disinfecting gas at the end of an infectious disease, but fumigation is now seldom used, and is unnecessary if the room is properly cleaned. It is a good plan to put a disinfectant in the wash water which is used in cleaning the sick room.

Breaking up the Travel Routes of Disease Germs. — The chief route for the spread of disease germs, namely, contact (p. 318), is broken up by means of isolation. On nearly all other routes the germs steal rides on things which enter the mouth, especially food and water.

A common route is that by *fingers*, in which the disease germs start from the body of the sick person with some excretion, stop for a while on dirty fingers, and may again stop on food which is touched by the fingers, and then pass into the body when the food is eaten. There are two ways of breaking this route:

1. The germs may get lost if the hands are washed.
2. They may be killed if the food is cooked.

The *fly* route of the germs leads to a collection of excretions of the body; then to a fly that stops at the excretions; then to food over which the fly crawls; and finally into the body of the person who eats the

food. The fly route may be easily broken in three ways:

1. The excretions may be destroyed.

2. They may be covered so that the fly cannot reach them.

3. The food may be screened so that the fly cannot reach it.

Another common route is that by means of *drinking water*, in which the germs start from the body with an excretion, stop for a while in slops or other sewage, stop again in drinking water into which the sewage runs, and finally reach the body when the water is swallowed. The ride of the germs is broken if the sewage is properly purified, or if its route of flow does not cross the route of flow of the drinking water.

One of the most important objects in the study of hygiene is to learn the courses of the routes of infection and the points at which they may easily be broken.

Producing Immunity. — There is always the danger that a route of infection will be left unguarded, and that some disease germs may be able to reach the body alive. But the germs can do no harm if the body can kill them before they can grow. The body can be made immune to diphtheria and lockjaw by injections of the antitoxins against those diseases. It can be made immune to smallpox, typhoid fever, and rabies by means of vaccines for those diseases. New discoveries are continually being made regarding antitoxins and vaccines.

Disease in a School. — When several children in a school have a disease, such as scarlet fever or diphtheria, there is often a demand that the school be closed in order to stop the disease from spreading. It is usually best that the school be kept open for the following reasons:

1. The children are under the eye of a watchful teacher, and often of a school nurse also, and a slight sickness will be noticed.

2. Children behave better in school than in almost any other place. Here they are orderly and clean, and are taught what to do in order to prevent the spread of disease.

3. Children out of school, having nothing to do, visit one another and come much closer together than they do at school.

4. If there is a school nurse, she will keep track of the children.

Diphtheria. — Diphtheria is one of the most common and most dangerous diseases in the United States. The methods of dealing with it will illustrate how a health officer deals with other infectious diseases.

Diphtheria is caused by diphtheria germs growing in the throat. The germs usually cause a coating, or membrane, like a thick, white scab, to form on the tonsils. The germs also form poisons, or toxins, which produce great weakness and sometimes death. There is usually some sore throat, or other signs that the throat is diseased. Whenever there is anything

wrong with the throat, diphtheria is the disease to think about. There are two things for a physician to do in order to find out whether or not the disease is diphtheria:

1. Look into the throat for a membrane.

2. Take a culture from the throat (p. 313). If diphtheria germs are present, the disease is diphtheria, even if little or no membrane is present.

The lives of many children every year are lost from diphtheria because they refuse to let a physician look into their throats or take a culture. A life may depend on the prompt discovery and treatment of diphtheria when the disease exists.

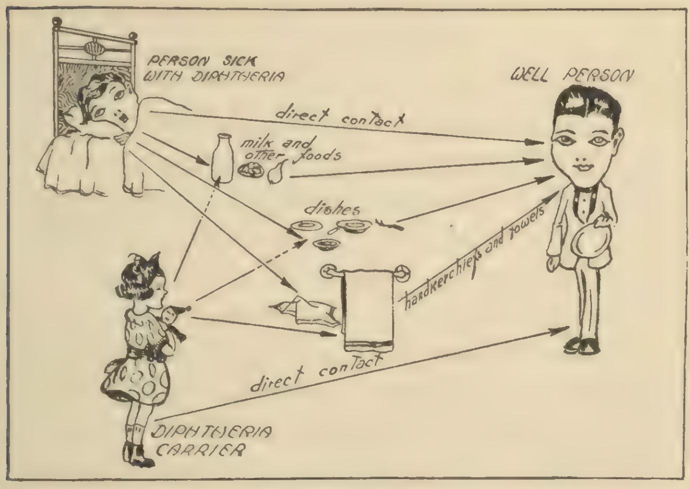
Diphtheria often looks like a disease called *tonsillitis*. The only safe rule is to take a culture from every sore throat. A physician or nurse does this by touching a small swab to the tonsils and then rubbing it over a jellylike substance in a glass tube. The swab carries germs from the throat to the tube, where they grow, and in a day or two the germs may be easily recognized. Many states and cities support laboratories in which diphtheria cultures are examined free.

Diphtheria germs travel from one person to another over three principal routes:

1. Direct contact.

2. Milk and other foods into which diphtheria germs have been put.

3. Handkerchiefs, towels, and dishes on which some one has left diphtheria germs.



THE MAIN ROUTES BY WHICH DIPHTHERIA IS SPREAD

There are three things for a physician to do with a person who has diphtheria:

1. Give him a dose of diphtheria antitoxin (p. 322).
2. Isolate him (p. 333).
3. Have the nurse destroy the excretion from his nose and throat (p. 334).

Antitoxin is an almost sure cure for diphtheria if it is given during the first day or two of the disease. It acts by destroying the poisons which are produced by the disease germs. If it is given late, it cannot overcome the damage which the poison has already done, just as water cannot restore the burned parts of a building. Antitoxin is so useful in diphtheria that some states supply it free.

The laws of most states require that every case of diphtheria shall be reported. Since the time when cases have been reported, cultures examined free, and antitoxin given away, the number of deaths from diphtheria has been reduced to less than one quarter of their former number. There are hardly any deaths when the disease is recognized and antitoxin is given early in the disease.

Diphtheria Carriers. — The isolation of a person for diphtheria is continued until no diphtheria germs are found in two successive cultures taken at least a day apart. The germs sometimes continue to grow in the throat for weeks and months after the person seems to be well, and the person remains a carrier who can spread the disease although he himself is well. The germs usually grow in unhealthy tonsils, and are no longer found growing when the tonsils are removed by an operation. Carriers of diphtheria germs are the cause of most cases of diphtheria at the present time.

Diphtheria in a School. — When diphtheria occurs among school children, there is seldom need to close the school, or any room in the school (p. 337). If a culture is taken from each child in the rooms in which cases have occurred, a carrier or two will probably be found to be spreading the disease. If the carrier is isolated, the other children may safely continue at school.

The Schick Test. — Over half of all persons have diphtheria antitoxin in their blood, and will not catch

diphtheria when they take its germs into their bodies. A test for antitoxin in the blood is that called the *Schick* test, after its discoverer. A physician makes the test by injecting a very little diphtheria toxin into the skin. If antitoxin is in the blood, it destroys the toxin, but if no antitoxin is present, the toxin makes a red spot on the skin. If you take the Schick test, you can know whether or not you can catch diphtheria.

If there is no antitoxin in the blood, a harmless mixture of toxin and antitoxin injected under the skin will act like a vaccine, and will cause the blood to form the antitoxin for years afterward. The Schick test and the injections of the toxin and antitoxin are given free in many cities.

Scarlet Fever. — Scarlet fever is a dangerous disease, and yet a child may have it in such a mild form that no physician is called, and the disease is not recognized. Two or three weeks after the beginning of the disease the epidermis begins to peel from the skin over all the body. If a person is suddenly taken ill with stomach sickness or vomiting, has a sore throat, and the skin on the chest becomes red, the sickness may be scarlet fever. If the skin begins to peel after two or three weeks, the sickness was almost certainly scarlet fever.

When cases of scarlet fever occur in a school, the health officer looks for three groups of children:

1. Those who have sore throat and are beginning to be sick.

2. Those whose skins are peeling as a result of having been slightly sick two or three weeks before.

3. Contacts (p. 330).

It is necessary to isolate the sick for thirty days from the beginning of the sickness, and to watch the contacts during the period of incubation of the disease, which is one week or less.

Some persons suppose there is a difference between scarlet fever and what is called scarlet rash, or rose rash. These are merely other names for scarlet fever. Scarlatina (skär-la-tē′nȧ) is the name used for scarlet fever in medical books all over the world.

Measles.—Measles is such a common disease that many parents expect their children to have it, and take no care to prevent it. The disease is usually mild, and yet often produces pneumonia, and causes more deaths than scarlet fever. It begins with sneezing and coughing, and running nose and eyes, as if the sick person had a cold. After about four days the skin begins to break out with red spots. The germs are given off from the nose and mouth from the beginning of the disease, and the sickness often spreads before the sick know that they have measles. It is necessary to isolate the sick for ten days from the beginning of the sickness, and to watch the contacts during the period of incubation, which is two weeks.

When measles occurs in a school, the health officer looks for two groups of children:

1. Those who have signs of a cold or the beginning of measles.

2. Contacts who have not had the disease.

Almost the first sign of measles is a fever. A nurse can usually find the cases by taking the temperature of every child that appears to be sick. If a child has a fever, the place for that child is at home and away from other children, no matter what the sickness may be.

Whooping Cough. — Whooping cough is like a cold, but the sick person often has a spell of coughing hard and long until nearly all the air is blown out of the lungs. An inspiration is then taken so suddenly that it causes a noisy whoop. The disease often leads to pneumonia, and is the cause of about as many deaths as scarlet fever; but it is often so mild that there is no whooping, and the disease is not recognized. A vaccine made of its dead germs is used for preventing the disease.

Typhoid Fever. — Typhoid fever is a disease of the intestine. It is often dangerous to life, but may be so mild that it produces only a stomach ache and weakness. Its germs leave the body with the excretions of the intestine and kidneys. Some persons remain carriers of typhoid germs for years after they have recovered from the disease.

The disease is spread by the excretions of the sick or

carriers, and by sewage containing the excretions. Some of the common routes of infection are:

1. Fingers soiled with excretions, carrying the germs either directly to another person, or to milk and other food.

2. Sewage flowing into drinking water.

3. Flies alighting on excretions or sewage, and then on food.

Typhoid fever may be prevented in two ways:

1. By blocking all the routes of infection.

2. By making the body immune by means of typhoid vaccine (p. 323).

Typhoid was formerly spread principally by drinking water containing sewage, but cities have now blocked that route by proper sewage disposal, and by providing pure water supplies. The disease is now spread largely by carriers who handle milk and other food. When an outbreak of typhoid occurs, a health officer looks for a carrier who caused it.

Hookworm Disease. — In the warmer parts of the United States there is a common form of sickness, called the *hookworm disease*, in which there is paleness and a great weakness that seems like laziness. The disease lasts for years, and is caused by worms about a quarter of an inch long which live in the upper part of the intestine. The worms suck blood from the mucous membrane, and also inject a poison through their bites.

The route by which the hookworm passes from the sick to other persons is as follows:

1. The worms lay eggs which pass out of the body of the sick person with the excretions of the intestine.

2. The eggs lie in the soil where they hatch microscopic worms.

3. The young worms enter the body by passing through the skin of the bare feet of persons who walk over the infected soil.

4. The worms enter the blood stream and pass with it to the intestine.

The disease may be prevented by breaking the route of infection at any one of several points:

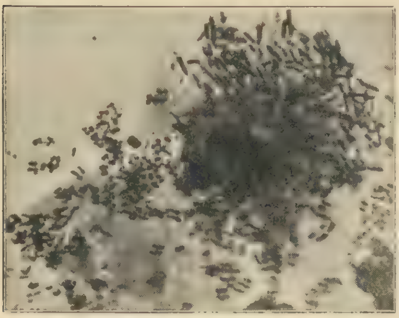
1. The worms may be killed in the intestine by means of a drug called *thymol*.

2. The proper disposal of excretions will prevent the eggs from reaching the soil.

3. Wearing shoes will prevent the young worms from entering the skin.

Diseases of the Air Tubes. — The air tubes from the upper part of the nose to the lowest part of the lungs form one open space with nothing to shut off one part from another. Disease germs which grow in one part of the tube may extend to other parts. The germs usually enter the body through the nose or throat. If they grow only in the nose, the sickness which they produce is usually called a *cold*. If the germs extend to the throat, the sickness is called a *sore throat* or *tonsillitis*; if they reach the air tubes below the throat, the sickness is called *bronchitis*; and if they grow in the air cells, *pneumonia*.

A Common Cold. — There is a common form of sickness, called a *common cold*, or a *cold in the head*, in which there are sneezing and coughing, pains in the nose and head, and often sore throat. Its germs are not very poisonous, and seldom grow below the nose and throat, or produce a severe illness. This form of sickness is often supposed to be caused by exposure to cold and wet; but it is infectious and is caused by disease germs which readily spread from one person to another. The disease is usually mild, and those who have it go among other persons as usual and spread their germs wherever they go. The sickness often comes in waves, or epidemics. When one person in a family has it, everybody else in the family is likely to catch it; and when a few persons catch it, they often give it to nearly everybody else in the town.



BACTERIA FROM THE NOSE OF A PERSON WHO HAS A BAD COLD

(Magnified 1000 times.) Nearly all kinds of colds are infectious and may spread from one person to another.

Many dangerous diseases are often mistaken for common colds. Any mild form of disease of the air tubes is often called a cold. Many colds are caused by the germs of pneumonia and influenza; and many are measles, or scarlet fever, or diphtheria in their early

stages or in mild forms. All these diseases, as well as common colds, are infectious and may be prevented by the same means.

Colds spread principally by contact of the sick with the well. The two principal means of preventing their spread are:

1. The isolation of the sick.

2. The disposal of the discharges from the noses and throats of the sick.

Colds will be prevented when everybody understands what a cold is and is willing to try to prevent its spread.

Influenza. — A great wave, or epidemic, of a disease called *influen'za*, or the *grippe* (grĭp), has swept over the world about once in thirty years. The last great epidemic began in 1918. The disease occurs in all degrees of severity, from a mild cold to a deadly pneumonia. It is extremely infectious, and is spread principally by contact. When it has appeared, most persons who have not had the disease have caught it. Few persons catch it the second time, and the disease has disappeared after everybody has had it; but it has reappeared about thirty years afterward, after the time that is needed to raise up a new generation of persons who have not had the disease.

Pneumonia. — Pneumonia is a disease in which the germs grow in the lungs and cause the air cells to become filled with liquid or solid matter. Pneumonia germs usually grow in the nose and throat for several days before they extend down the air tubes and into

the air cells. The disease which they produce seems like a common cold while the germs are growing in the nose and throat; but the sickness becomes worse as the germs extend down the air tubes until finally it becomes dangerous pneumonia. What is supposed to be only a common cold may be caused by pneumonia germs, and may be the beginning of pneumonia. Many colds are caused by pneumonia germs which do not extend below the throat.

Pneumonia is an infectious disease, and is caught from some one who either has the disease, or has a cold that is caused by pneumonia germs. The three principal means of its prevention are:

1. Isolation of the sick.

2. The disposal of excretions from the noses and throats of the sick.

3. Any means which promotes strength and vigor of the body, for such means will also promote immunity to pneumonia.

Immunity to pneumonia germs is lessened by any injury or weakness of the body. The pneumonia germs may be able to grow only in the nose and throat if a person is strong and well. But if that person is weakened by fatigue, or by exposure to cold, or by drinking alcohol, or by any other means, the pneumonia germs which enter the body may extend down the air tubes to the lungs. But there will be no pneumonia, or even a cold, unless disease germs are present to produce it.

QUESTIONS

Why does the law require physicians to report all cases of infectious diseases to the health officers?

What common diseases must be reported?

How will a health officer find cases which are not reported?

What are *contacts?* Into what two groups are they divided?

Why does a health officer search for contacts when he is called to a case of infectious disease?

Why does a health officer inquire particularly about the date of onset of a disease? the date of exposure?

By what four means does a health officer try to prevent the spread of an infectious disease?

What is *quarantine? isolation?*

What care should be given to the excretions from one who has an infectious disease?

What is a *disinfection?*

Describe some means of disinfecting excretions; of disinfecting a room; of disinfecting clothing and toilet articles.

Describe some of the means of breaking up the routes by which disease germs may be carried.

How may the body be made immune to a disease?

Why should a school not be closed when an epidemic occurs in a town?

Describe *diphtheria.* How may diphtheria be recognized? How may it be told from tonsillitis?

Why should a culture be made from every sore throat?

What three things should be done with every person who has diphtheria?

Why should antitoxin be given?

What is a diphtheria *carrier?*

What is the *Schick* test?

In what two ways may a person be made immune to diphtheria?

Describe scarlet fever.

When scarlet fever occurs in a school, for what three groups of children will the health officer search?

What signs does a child show at the beginning of measles before the skin breaks out?

What is the danger from whooping cough?

Why should every child who coughs be sent home from school?

How is typhoid fever spread?

Describe *hookworm disease.*

Describe the route by which the hookworm passes from one person to another.

What diseases may disease germs produce when they grow in the air tubes?

What is meant by the term *a common cold?*

What dangerous diseases are often like colds?

How are colds spread?

How is pneumonia spread?

What are the three principal means of preventing pneumonia?

For the Teacher. — The object of this chapter is to explain the effective methods which a modern health officer uses in preventing the spread of infectious diseases. The influence and opportunities of the teacher in preventing infectious diseases are almost as great as those of the health officer and family physician. The teacher occupies a position of trust and responsibility in caring for the health and welfare of the pupils during several hours of each day. Her opportunities for teaching and demonstrating the methods of coöperation of the public with the health department are even greater than those of the health officer and physician.

When a case of infectious disease occurs in the school, let the teacher use the opportunity to instruct the pupils regarding the methods which are used to prevent the spread of the disease. If possible, have the health officer visit the school and talk to the pupils. Above all let the teacher insist on keeping the school open, and on having the pupils examined every morning by a physician or nurse in order to detect every case in its incipiency before it can spread infection to others.

Let the teacher learn from the health officer or physician how to recognize the signs of a beginning infectious disease, and the measures to take with the pupil who shows the signs of a beginning sickness. A teacher can readily do this, and can thus become the most valuable ally that the health officer has.

Emphasize the need of coöperating with the health officer in finding the dates of onset and exposure, and in discovering contacts, and other infected cases.

Emphasize the fact that while disinfectants and fumigations have some value, yet their use is only a beginning of the real work of preventing diseases.

A teacher can render valuable assistance in keeping track of *contacts*, or those children who have been exposed to cases of infectious disease, and are likely to come down with the sickness.

CHAPTER XXVIII

TUBERCULOSIS

Tuberculosis, the Modern Pestilence. — Formerly, when little was known about the causes of diseases and about their prevention, plagues and pestilences, such as smallpox, scarlet fever, and cholera, used to sweep over the land and kill large numbers of the inhabitants each year. We now know how to keep them from spreading, and have almost wiped out those diseases which come suddenly and kill quickly. Yet one great pestilence is still among us. Tuberculosis, or consumption, is a disease which now kills 125,000 persons each year in the United States, or more than the number of soldiers who were killed in battle during the Civil War. It is often called the great white plague, because it is very common among white races, and because those who have it become pale, and slowly waste away. About one tenth of all deaths in the United States are due to it, and yet it may be prevented.

Bacteria of Tuberculosis. — Tuberculosis is caused by a kind of bacteria growing in the body. They grow in the lungs more often than in other organs. They sometimes grow in the bones or joints, and there give rise to forms of hip-joint disease, hunchback, and

other troubles. They may grow also in the brain, the skin, the intestine, and in most other parts of the body. Tuberculosis of the lungs is often called consumption.

Cows may have tuberculosis, and the germs may then be found in their milk. The flesh of diseased animals may also contain the germs. Government inspectors are sent to slaughterhouses to examine the animals that are killed, and to destroy meat which contains signs of the presence of the germs.

How Tuberculosis Is Taken. — A person catches tuberculosis from some person, or some animal, that has the disease. The germs are not given off by the breath, or by the sound skin, but the phlegm that is spit out from the mouth of the sick contains them. Drying and freezing do not kill the bacteria, and when they rise as dust, another person may breathe them and catch the disease. The germs may be carried to food by house flies. The bacteria sometimes enter the body through pricks, or cuts, and also by means of milk or meat from cattle which have the disease.

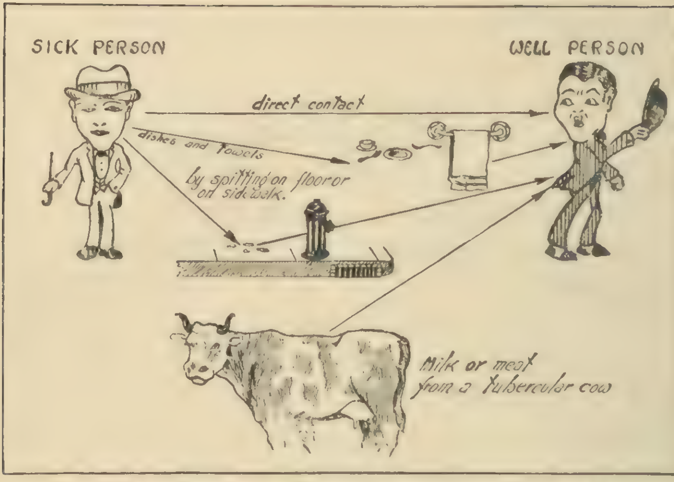
The bacteria do not grow within the body of every one who breathes them, for in a strong, healthy body the white blood cells destroy them, and substances in the blood prevent their growth. But if a great number of the bacteria enter the body at one time, the blood may be unable to overcome them all. If the body is weakened by overwork, or by indigestion, or a cold, or other sickness, the bacteria may grow, even though only a few enter the body.

Signs of Tuberculosis. — A person who has tuberculosis has little pain and feels but little sickness at the beginning of the disease. He usually feels tired, loses weight and strength, and often supposes that his feelings are due to hard work. He usually coughs as if he had a cold. Having a cough for some weeks, and losing flesh and strength, are two common signs of tuberculosis.

Another sign of tuberculosis is a fever. A mild cold does not usually cause a fever, but if a person who seems to have had a cold for some weeks has a fever every afternoon, it is likely that he has germs of tuberculosis growing in his lungs.

Scrofula. — Children sometimes have a disease, formerly called *scrof'ula*, in which the lymph glands of the neck become enlarged and form hard swellings. The swellings may become red and tender, and may contain pus. They are often caused by tuberculosis germs which enter the glands through the throat. Adenoids and enlarged tonsils are two common throat troubles which allow the germs to enter the flesh and the glands. If the disease is neglected, it may produce tuberculosis of the lungs.

Tuberculosis of Bones. — A bone or joint that has tuberculosis is swollen and tender, and the bone itself becomes softened. A bone or joint that slowly becomes sore and swollen probably contains the germs of tuberculosis. The hip joint is often affected with tuberculosis.



THE MAIN ROUTES BY WHICH TUBERCULOSIS IS SPREAD

How Tuberculosis Germs Are Spread. — If a person has tuberculosis, the principal way by which germs of the disease leave the body is in the mucus, or phlegm, that is spit from the throat. This mucus is called *spu'tum.* Tuberculous persons usually cough often, and spit up a great deal of sputum. Thousands of persons who have the disease spit upon public streets and the floors of workrooms. The germs become dried and float in the air as dust. For this reason the dust from city streets, and the air of poorly ventilated workrooms usually contain the germs of tuberculosis. Those who work day after day in crowded shops are almost sure to take germs of tuberculosis into their bodies, and these germs are likely to grow if the workmen are overworked or underfed.

Spitting. — Spitting on pavements and on floors is one of the principal means of spreading tuberculosis. Persons often have tuberculosis without knowing that they have the disease, and so it is not safe for any one to spit on pavements and floors. Spitting on these places is so dangerous that the laws of most states and cities forbid it, and signs are posted in cars and public places telling of the punishment which may be given to those who break the law.

Disposal of Sputum. — If those who have tuberculosis will catch and destroy all their sputum, they may safely go among other persons. While they are away from home, they may catch the sputum in clean handkerchiefs which they may safely carry in waterproof pockets. They may then kill the germs by boiling the handkerchiefs when they get home. While the sick person is at home, he may catch his sputum in paper cups, and burn them at the close of the day.

Using a spittoon is almost as dangerous as spitting on the floor, for a spittoon cannot be cleaned, and flies may crawl over it and carry away the disease germs to other persons.

A tuberculous person will sometimes soil his face and hands with sputum. Cleanliness of the skin is of great importance in preventing the escape of the germs.

Contact with Tuberculosis. — The most frequent way of catching tuberculosis is through direct contact with a tuberculous person, as by kissing, sleeping in the same bed with the sick, drying the face on the same

towel, and eating from the same dishes. The husbands, wives, and children of the sick are more likely to catch the disease than others, for their faces often come close to the faces of the sick, and they often use the same toilet articles as the sick use. But the sick may safely live among their families if they are cleanly, have their own toilet articles, and keep their faces away from the faces of others who are near them (p. 317).

Protection against Tuberculosis. — There are two principal means of preventing tuberculosis:

1. Preventing its germs from entering the body.
2. Keeping the body so healthy and strong that the germs will not grow if a few should enter it.

One means of preventing tuberculosis germs from entering the body is to guard against coming into close contact with a person who has tuberculosis. Another way is to avoid those things which may contain the germs, such as public drinking cups (p. 223), toilet articles that have been used by other persons, impure milk (p. 293), and meat from diseased cattle (p. 352).

Any means which will make the body strong and healthy will also help it to overcome any germs of tuberculosis that may enter it. Some of these means are deep breathing (p. 135), exercise and rest (p. 87), and proper eating (p. 271).

The germs of tuberculosis often enter the body by means of foul and dusty air which is breathed. Foul

air is also one of the principal causes of weakness and poor health. By always breathing pure air, one may prevent tuberculosis germs from entering the body, and may also help to make the body strong enough to overcome the germs. The chapter on ventilation is important in connection with the prevention of tuberculosis (p. 161).

Curing Tuberculosis. — Tuberculosis may usually be cured if it is treated early. The signs of cured tuberculosis may be found in over half of the bodies which are examined after death. Many persons get well from an illness that they never knew was tuberculosis.

Four things are necessary in curing tuberculosis:

1. Fresh air.
2. Good food.
3. Rest.
4. Disposal of sputum.

Fresh Air. — One of the most important of all things in curing tuberculosis is fresh air all the time, day and night. The sick must have it even if the air is cold. Cold air is not dangerous. It is not even uncomfortable if plenty of clothing is worn. In those hospitals in which the greatest number of cases get well, the sick live out of doors all day, and sleep in porches which are wide open to the air and are connected with warm dressing rooms.

Good Food. — Another thing which will help to cure a tuberculous person is good food. The sick cannot build flesh and strength out of medicines, or out of

anything else except food. They need all the good food that they can digest, but no more. Overfeeding is as harmful to a consumptive as to a healthy person. The sick need meat, eggs, milk, and other foods that may be easily digested, and are also rich in protein, for they must build new flesh like a child (p. 272). One of the best signs of improvement is a gain in weight.

Rest. — A third thing which tuberculous persons need is rest, for they need all their strength to overcome the germs of the disease. A little exercise is helpful, but the sick must not get tired.

A great many persons die of tuberculosis because they do not stop hard work when they begin to be sick. They may safely do as much work as their strength will allow without their becoming tired.

Care of Sputum. — A fourth thing to do in order to recover from tuberculosis is to destroy the germs in the sputum. A person may start the germs growing in new parts of the lungs, or flesh, by taking them back into the body. Many fail to get well because they are uncleanly and do not take care of their sputum. Sunshine in the room, and cleanliness of the floors and furniture, are also necessary in order to kill all the germs that are in the sick room.

Teaching about Tuberculosis. — One of the most important steps in both the prevention and the cure of the disease is to teach all persons about it, in order that they may support sanatoriums and hospitals for its cure and provide proper housing and working conditions for

the prevention of the disease. Many cities and states have societies which send out printed instructions about tuberculosis. Some states have exhibitions of charts, pictures, and models, showing how the disease may be prevented and cured.

Sanatoriums. — Many cities and counties have hospitals and sanatoriums for the care of persons who have tuberculosis. One of the most valuable uses of these places is to teach the sick how to breathe, how to eat, how to exercise, and how to live in the best way to get well and stay healthy.

QUESTIONS

Why is tuberculosis called the great white plague?

Out of every one hundred deaths in the United States how many are caused by tuberculosis?

What is the cause of tuberculosis?

If a person has tuberculosis of the lungs, from what part of the body does he give off the germs of the disease?

How do tuberculosis germs usually enter the body of a well person?

What are some of the first signs that appear when a person has tuberculosis?

What is *scrofula?*

How are tuberculosis germs usually spread?

What harm is done by spitting on pavements and floors?

How can a person who has tuberculosis destroy the germs in his sputum?

How may the germs of tuberculosis be prevented from entering the body?

How may the germs of tuberculosis be prevented from growing after they have entered the body?

Of what use is fresh air in curing tuberculosis?

How much food does a person who has tuberculosis need to eat?

Of what use is rest in the cure of tuberculosis?

Why is the destruction of the sputum necessary in curing a person of tuberculosis?

Give some reasons why every person should learn about the prevention and cure of tuberculosis.

For the Teacher. — Refer to the subject of poor nutrition in Chapter XXII. Tuberculosis is a common cause of poor nutrition, and, on the other hand, poor nutrition is usually one of the earliest signs of beginning tuberculosis.

Nearly every person receives a few germs of tuberculosis into the lungs at some time during childhood; but the body usually overcomes the germs so that they give no sign of their presence. It may be that a few germs of tuberculosis in the body act as a vaccine and cause the body to form protective substances which prevent the growth of germs which enter the body later.

Emphasize the fact that proper correction of the three causes of poor nutrition which are mentioned on page 271 will usually enable the body to overcome the germs of tuberculosis which may be in the body.

The measures which are used to cure tuberculosis are those which enable a well person to keep his body strong and vigorous.

A child who is in the earliest stage of tuberculosis is not a menace to others and may be allowed in school, for he seldom gives off the germs of his disease until he has a cough. But any coughing child should be excluded from school, for he will give off the germs of the disease which is causing the cough.

A child who has a fever should be sent home and put to bed for his own sake, whether he has tuberculosis or not. Fever is always a sign of serious illness, and rest in bed is a necessary part of its treatment.

CHAPTER XXIX

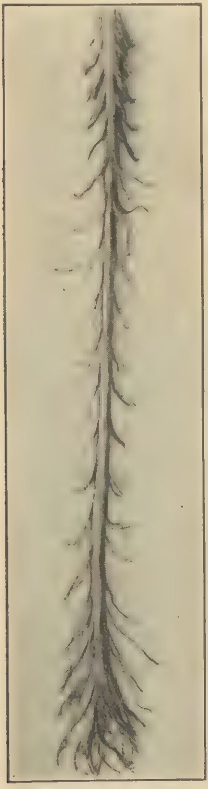
THE NERVOUS SYSTEM

Need of a Nervous System. — Every part of the body must have help from other parts in order to live. The arm cannot live unless it receives blood from the heart, food from the stomach, and oxygen from the lungs; and it cannot work unless it receives orders from the brain. Each organ must help all the rest of the body, and so it must receive directions telling it when to act, and how much to do. The work of directing the actions of the different organs of the body is done by the organs of the central nervous system.

THE BRAIN, SIDE VIEW
($\frac{1}{4}$ natural size.)

Central Nervous System. — The principal organs of the central nervous system are the *brain* and the *spi'nal cord*. The brain fills the top of the skull above the eyes and ears. The spinal cord is about as large

around as a little finger. It hangs inside of the backbone, and extends from the brain about to the waistline. The brain and the spinal cord are almost as soft as jelly; but they are protected from injury by the heavy bones of the skull and the backbone.



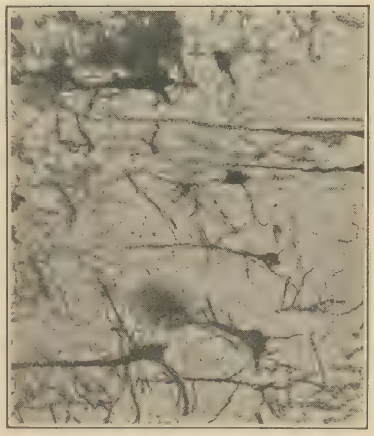
THE SPINAL CORD

(¼ natural size.) The strings at the sides are the beginnings of nerves.

Nerves. — The brain and spinal cord are connected with all the other organs of the body by threads of flesh called *nerves*. Twelve pairs of nerves are joined to the lower part of the brain, and thirty-one pairs to the spinal cord. The use of nerves is to carry messages between the organs of the body and the central nervous system.

Nerves are like telephone wires. The stomach, lungs, muscles, skin, and all other parts of the body are like customers who have telephones in their houses. The brain and spinal cord are like central telephone stations which the customers call up when they wish to send messages. Nerves do not run directly from one organ to another, but nearly all messages between the organs pass through either the spinal cord or the brain.

Nerve Cells. — The parts of the brain and spinal cord that receive and send messages are called *nerve cells*. The nerve cells are so small that they cannot be seen without a microscope. They have small bodies and long branching arms. Some of these branches are the nerves which go to all parts of the body. Other branches of the cells extend to other nerve cells. The nerve cells are like the operators in a central telephone station. Their use is to receive and to send messages which pass between the different parts of the body.



Nerve Cells from the Brain

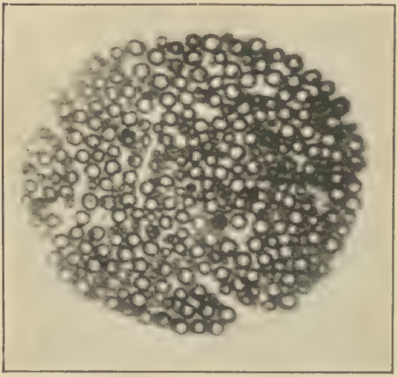
(Magnified 200 times.) A nerve is a prolongation of one of the branches of a nerve cell.

The brain and the spinal cord consist of nerve cells and nerves. That part which contains nerve cells is reddish gray in color, and is called *gray matter*. That part of the brain and spinal cord which consists of nerves is white in color, and is called *white matter*. Gray matter covers the outer part of the brain, but it forms the central part of the spinal cord.

Motor Nerve Messages. — Most of the messages which nerve cells send out are orders to do something. Any nerve which carries messages away from

the central nervous system is called a *motor* nerve. There are four principal kinds of motor nerve messages:

1. Some of the motor messages are orders for the cells all over the body to take food and grow. When a muscle is exercised, it grows large, because the spinal cord sends orders for it to take a large quantity of food from the blood in order to do its work well.



A Nerve Cut Across

(Magnified 100 times.) A nerve is like a telephone cable containing many nerve fibers.

2. Some of the motor messages are orders for the glands to secrete their liquids. When the stomach receives food, the spinal cord sends orders for the glands to manufacture gastric juice.

3. Some of the motor messages are orders for the involuntary muscles to contract. When cold air strikes the skin, the spinal cord sends orders for the muscles of the arteries to contract, so as to keep the blood away from the skin.

4. Some of the motor messages are orders for voluntary muscles to contract (p. 84). Every motion of a muscle is ordered by the nerve cells. If no orders reach the muscles, a person cannot move, and we say that he is *paralyzed*.

Sensory Nerve Messages. — The messages which the organs send to the brain and spinal cord are called *sensory* nerve messages, because many of them produce feelings or sensations. One class of sensory messages are those by which the organs tell of their need of food, or oxygen, or rest. After hard exercise the feeling of shortness of breath is the message by which the muscles tell the brain of their need of oxygen. If it were not for the sensory nerve messages, the brain and spinal cord would not know what orders to send to the various organs.

Other messages that the organs of the body send to the brain are those telling about things which are outside of the body. These messages are sensations of touch, sight, hearing, smelling, and tasting, and are called the *five senses.*

If something which is touching the body harms it, the feeling which is produced is one of pain in the injured spot. Pain is often a useful feeling, for it gives warning of danger to the body.

Conscious Nerve Actions. — Nerve actions may be divided into two classes: first, those which can be felt, called *conscious nerve actions;* and second, those which cannot be felt, called *unconscious nerve actions.*

We are usually conscious of only two kinds of nerve actions: first, the motor messages to the voluntary muscles; and second, the sensory messages which the brain receives through the five senses. Nearly all other nerve messages are sent and received without our

knowledge. For example, we are usually conscious of sending orders for the movements of our arms and legs, and receiving messages of sight and hearing; but we are not conscious of the messages which order the flow of gastric juice, or of the messages by which the muscles tell of their need of food. The number of unconscious nerve actions is far greater than those of which we are conscious.

The nerve messages of which we are conscious are either received by, or are sent from, the nerve cells of the gray matter in the upper part of the brain. We therefore say that the upper part of the brain is the seat of *consciousness*, and of the mind. These cells do the work of thinking, and send out the orders for voluntary movements.

Unconscious Nerve Actions. — The messages which control the acts of secretion and growth, and the movements of the involuntary muscles, are either received by, or are sent out from, the nerve cells in the spinal cord and in the lower part of the brain. These actions are not under the control of the mind; they go on whether a person thinks about them or not, and whether he is asleep or awake.

When the nerve cells of the upper part of the brain are injured, as by a blow on the top of the head, a person is unconscious, like one in a deep sleep. But life, growth, and repair of the body may still go on if the nerve cells of the spinal cord and lower part of the brain are in good order.

Relation of Brain and Spinal Cord. — The gray matter of the upper part of the brain is like a man who drives an automobile, but does not repair the car or keep it in order. The work which the driver does is like the conscious work of the brain.

The gray matter of the lower part of the brain, and that of the spinal cord, is like a workman who sees that the car is repaired and kept in good order, but does not run the car. The work which the repair man does is like the unconscious work of the spinal cord and the brain.

The Spinal Cord and Voluntary Movements. — The cells of the spinal cord and of the lower part of the brain usually act only in answer to messages which they receive from some other part of the body. Some of the messages telling them to act come from the nerve cells of the upper part of the brain. When a person wishes to move a muscle, the cells of his brain send an order to the cells of the spinal cord, and they repeat the message to the muscles.

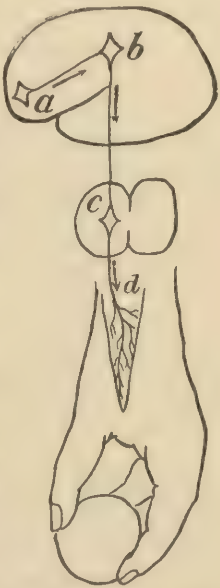


DIAGRAM OF A NERVE MESSAGE IN VOLUNTARY MOTION

a, nerve cells in the thinking part of the brain, which start the message; *b*, nerve cells in the motor part of the brain; *c*, nerve cell in the spinal cord; *d*, nerve which carries a message to a muscle of the hand.

Reflex Action. — The cells of the spinal cord and

brain often send out orders in answer to sensory messages which they receive from the organs of the body. When a person pricks his finger with a tack, the finger sends a sensory message of pain which passes through the spinal cord on its way to the brain. The

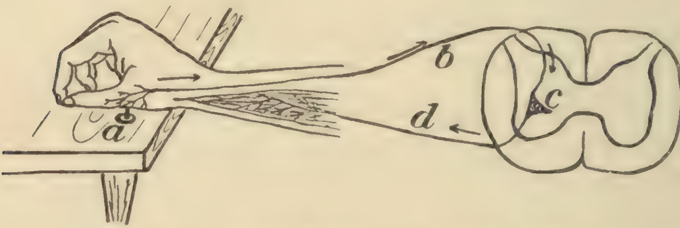


DIAGRAM OF A NERVE MESSAGE IN REFLEX ACTION

a, a tack pricking the hand; *b*, nerve carrying a message of the prick to the spinal cord; *c*, nerve cell in the spinal cord; *d*, nerve carrying a motor message to a muscle ordering it to snatch the hand away from the tack.

cells of the spinal cord at once reply to the message by ordering the muscles of the arm to take the hand away from the tack, and the finger is already snatched away from danger by the time the message of pain reaches the brain.

The action of the brain and spinal cord in sending a motor nerve message as a result of a sensory message is called *re'flex action*, because the sensory message seems to be reflected, or turned back, as a motor message.

Nearly all the messages for secretion and growth, and for movements of involuntary muscles, are reflex messages. For example, the cells of the spinal cord do not send orders for the stomach glands to produce

gastric juice until they receive word that food is on its way to the stomach. They order the arteries of the skin to contract when they get a message that something cold is touching the skin.

Sympathetic Nervous System. — The spinal cord does a great deal of its work with the assistance of sets of nerve cells called *ganglia* (găng′glĭ-a). The principal ganglia are arranged in a double row of twenty-three pairs down the whole length of the backbone. They are about the size of grains of wheat or oats, and are connected with the spinal cord by means of nerves. Other nerves go from them to the arteries, and to the organs of digestion, respiration, and excretion. The ganglia and their nerves form what is called the *sympathetic* nervous system.

The ganglia send orders to the organs to do those kinds of work which go on slowly and steadily, such as the contraction of the arteries, the peristalsis of the stomach and intestine, and the secretion of saliva and gastric juice. They have very little nerve power of their own, but they get most of their power from the spinal cord. The spinal cord itself acts in a quick and forcible way, as in its reflex action when the finger touches a tack. The ganglia slow down the messages of the spinal cord and send them out in a gentle and continuous stream. For this reason the actions on which life depends, such as digestion, circulation, and excretion, go on slowly and regularly, and are not readily disturbed.

A disorder of any part of the body affects other parts through the sympathetic nervous system. For example, those who have eye troubles often suffer with headaches and stomach sickness. Adenoids in the throat interfere with the growth and strength of the whole body, even though they do not produce pain or a feeling of sickness. A weakness of any part of the body may prevent other parts from being strong.

QUESTIONS

Why does a person need a nervous system?

What are the principal organs of the nervous system?

Where is the brain situated?

Where is the spinal cord situated?

Where are nerves found?

Compare nerves with telephone wires.

What are nerve cells?

Where are nerve cells found?

Of what is the gray matter in the central nervous system composed? the white matter?

What are motor nerves?

What are some of the messages that are carried by motor nerves?

What are sensory nerves?

What are some of the messages that are carried by sensory nerves?

What are conscious nerve messages?

Name some nerve messages of which a person is conscious.

Name some unconscious nerve messages.

What is reflex nerve action?

Explain the nerve action which takes place when a person snatches his hand away after pricking his finger with a tack.

What part does the spinal cord take in conscious nerve acts?

Where is the sympathetic nervous system found?

Of what does the sympathetic nervous system consist?

Over what actions does the sympathetic nervous system have control?

Where does the sympathetic nervous system get its power to act? Why does a disorder of a single organ affect the whole body?

For the Teacher. — The object of this chapter is to present the subject of the nervous system in a simple, practical way, and in outline only. It is scientifically correct to compare the nervous system with a telephone system. The comparison is a great help in enabling the pupils to understand the nervous system.

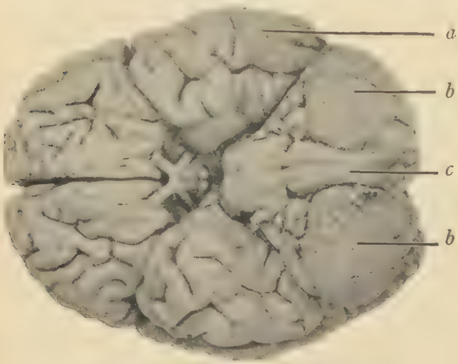
A little comparative anatomy will be an additional help in understanding the nervous system. The lower forms of animals, such as worms, have nerves and nerve cells, but all the cells are grouped in a row of ganglia of the sympathetic system. Man has the same sympathetic system, and its action is about the same as that of a worm, for a man eats, digests food, grows, and carries on his other life-sustaining actions in about the same way that a worm does. A fish has an excellent sympathetic system and spinal cord, but its brain is small and rudimentary. But that part of the brain which is used in seeing is as fully developed as the same part of a brain in man, for most fish can see well.

As we pass upward through the various grades of animals from the lowest to the highest, we find that additional brain substance is added according to the intelligence of the animal. A dog, for example, has well-developed brain parts which have to do with its senses and muscular movements, but the thinking parts of its brain are small. In man the uppermost or thinking parts of the brain are so large that they overlap all the rest; but those parts which are concerned with the senses and movements are scarcely larger than they are in a dog.

CHAPTER XXX

THE BRAIN

The Three Parts of the Brain. — The part of the central nervous system which is inside of the skull is called the brain. The greater part of the brain is a large mass which fills almost all the space under the rounded top of the skull. This part is called the *cerebrum* (sĕr′ē-brum). Under its hinder end is a smaller mass called the *cere-bel′lum.*



Human Brain, Underside View

(¼ natural size.) *a*, cerebrum; *b*, cerebellum; *c*, medulla.

A slender stem of nerve matter from the cerebrum and cerebellum extends downward, and is continued outside of the skull into the backbone. The part of the nerve stem which lies inside of the skull is called the *medul′la.* That part of the stem which lies outside of the skull is the spinal cord.

The brain, spinal cord, and nerves may be compared to a tree. The spinal cord and the medulla are like the tree trunk. The nerves which go from the spinal cord to all parts of the body are like the roots of the tree. The cerebellum and cerebrum are like the rounded top of the tree.

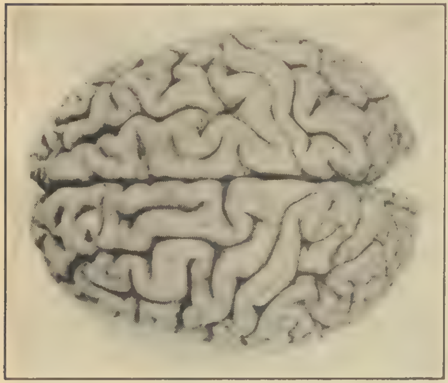
The Medulla. — A person's medulla is about as wide and half as long as his little finger. Nerves extend from it to all parts of the head and neck, just as nerves from the spinal cord extend to all other parts of the body.

The white matter of the medulla consists of nerve threads which join the cerebrum and cerebellum to the spinal cord. Some of the nerve cells of the gray matter of the medulla control the motions of the muscles of the head and neck, and other cells have some control over the heart.

A small group of nerve cells which lie near the center of the medulla within a space about the size of a pea have control over the movements of breathing. If these cells were destroyed, breathing would stop at once, and death would occur almost instantly. This part of the medulla is sometimes called the seat of life.

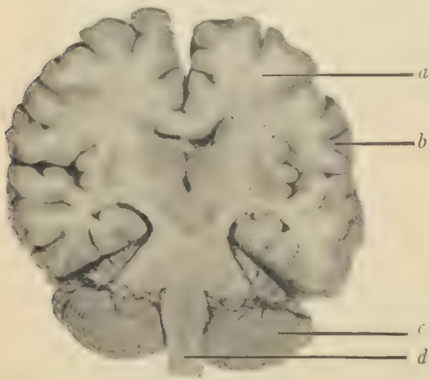
The Cerebellum. — The cerebellum is about the size of a large hen's egg. Its outer part consists of gray matter whose cells control the movements of the muscles in balancing the body, as in standing or running. The cells also cause the muscles of the body to act in a regular and orderly manner in making a number of quick and exact motions, as in playing a piano.

The Cerebrum. — The cerebrum is about five times as large as all the rest of the central nervous system put together. It covers the rest of the brain, and is the only part which is seen when the rounded top of the skull is removed. It consists of gray matter covering a central mass of white matter. The cells of the gray matter are the seat of the mind, and of conscious nerve action (p. 365). The white matter consists of nerve threads which connect the nerve cells with each other and with the rest of the body.



Human Brain, Top View

(¼ natural size.) All that can be seen is cerebrum.



Human Brain, Cut in Two Crosswise

(¼ natural size.) *a*, white matter of cerebrum; *b*, gray matter of cerebrum; *c*, cerebellum; *d*, medulla.

The surface of the cerebrum is folded and crumpled, and looks as if its covering of gray matter

were too large for it. Because of the folding, the amount of gray matter is about three times as much as it would be if the brain were smooth. A child is born with a very few folds on its brain, but as its mind grows, the folds on its cerebrum also grow in number and size.

The Work of the Mind. — The mind acts by means of the nerve cells of the cerebrum. These cells do three kinds of work: first, they receive sensory messages by means of the five senses (p. 365); second, they send out motor messages to the voluntary muscles; and third, they think.

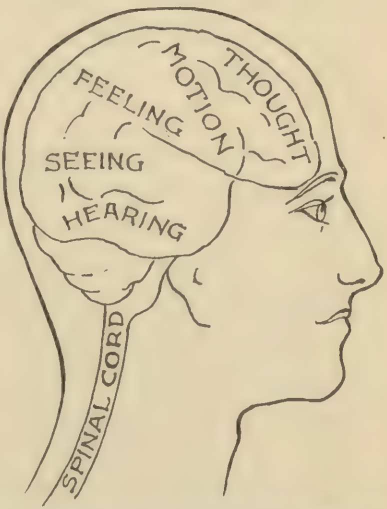


Diagram of the Action of the Different Parts of the Brain

Each part of the brain has one kind of work to do. The cells in the part of the cerebrum behind the ears receive messages through the five senses. Those just above and in front of the ears send out orders for moving the voluntary muscles. Those in the front part of the cerebrum do most of the work which is called thinking.

Memory and Thinking. — The nerve cells of the cerebrum keep a record of the messages which they

receive and send out. This record is called the *memory*, and the messages which are recorded in it form a person's *knowledge*.

A person can look over the messages which he has stored in his memory. He can compare them with one another and in this way he can get new knowledge. This work of the mind is called *thinking*.

Training the Mind. — The nerve cells of the cerebrum have many branching arms which extend to the nerve cells in other parts of the brain. By means of these branches a nerve cell knows what other cells are doing.

Brain cells and their branches grow by use, just as muscles grow by exercise. The brain cells of a baby are small, and their branches are few and short, but the branches grow in number and length as the child's mind grows. Your muscles and bones will stop growing when you are about twenty-five years old, but your brain cells may grow until you are about fifty years old, if you exercise your mind and train it.

When you stop studying and thinking, your brain cells stop growing. If you leave school when you are fifteen years old, and do not study or think hard after that age, your brain cells will also stop growing, and you will always have the mind of a fifteen-year-old child. But if you study, and read, and think, your brain cells and your mind will keep on growing for many years after your bones and muscles are full-grown.

When you read a book about a bell or other object,

you use the nerve cells which think. When you see a bell, or hear it, you also train the nerve cells which receive messages from the eyes and ears; and when you ring a bell, you train the nerve cells which send motor messages to your hands. Thus you may train your mind by seeing and hearing, and by working with your hands, as well as by reading.

Most mental training at school consists in teaching the thinking cells which lie just behind the forehead. But you will not be educated unless the cells by which you send motor messages, see, and hear, also receive training.

Laboratory work in school, and working in a carpenter shop, are as much a part of mind training as studying a book or listening to a speech. A boy who has been trained only from books at school or college has to start work in a low position in a shop or store in order to train that part of his brain which was not trained at school. But the boy who has trained his forehead cells to think will soon be able to train the rest of his brain.

Habits. — When you recall anything to memory, the cells of your brain try to do the same thing that they did when they formed that memory. When you think about a flower, the cells which receive messages of sight recall the messages which they have received about the color of the flower, and you can seem to see the flower again even when you close your eyes. When you recall an act to memory, the cells which sent out

the orders from the brain when the act was done want to send out the orders again when you think of the act.

After your brain cells have done an act a few times, they often try to repeat the act, whether you wish them to do so or not. We then say that you have a *habit* of doing that act. Every person forms habits in his work and play. Some persons form habits of always getting up early, eating properly, acting politely, and speaking pleasantly. All these are good habits.

Forming Good Habits. — You form most of your habits while you are young. The good habits which you form will be as lasting as the bad ones. Every one forms habits in his eating, dressing, speaking, thinking, sleeping, walking, and in doing all the other acts of everyday life. All these habits have an effect on the health of the body. For example, the things which a person eats, and the way in which he eats them, are among the principal things which affect health. Yet most grown persons eat in the way in which they formed habits of eating while they were young. Those whose eating habits are right seldom have indigestion or stomach troubles.

You will easily fall into bad habits if you are careless and do not think about your actions. Some boys and girls think they can do a forbidden thing a few times without forming a habit of doing it. There is danger in doing any wrong or improper act, for by repeating the act you will do it more and more readily until you will

do it without thinking. Do not begin to do a wrong or improper act at all.

You can overcome a bad habit if you put a right habit in its place. The cells of your brain will slowly forget what is stored in memory if you do not recall it to mind. If you wish to overcome a bad habit, watch yourself and do the act in the proper way. Your brain cells will then forget the wrong way of doing the act, and you will form a habit of acting properly.

Habits of Mental Health. — It is your duty to form wholesome habits of thought. You can form the habit of thinking good of a person instead of evil; of being cheerful instead of glum and morose, truthful instead of deceitful, patient instead of irritable, courageous instead of fearful, kind instead of hard-hearted, industrious instead of lazy, and coöperative instead of selfish. These and similar habits of thought will make you pleasing to others, and will help you to be successful in life.

Mental Habits and Social Relations. — The respect which your fellows and companions show to you will depend on the respect and consideration which you show to them. Your success in holding a position will depend on how well you please your employer, not only by your good work, but also by your good manners and the respect which you show to others. Good manners and courtesy are the result of good mental habits. A gentleman has the habit of showing respect to those in authority, obedience to the law, consideration to his

parents and other members of his family, and courtesy to all. He is willing to assume the obligations of citizenship, and to give service to society in return for the benefits which he receives from the public.

Directing the Thoughts. — You can turn your thoughts to anything you wish, but your mind can do only one thing at a time, and do it well. When you try to do an arithmetic example, you forget your work if you look out of the window, or listen to a noise, or whisper to some one. If you have a hard example to do, you can do it best if you keep your whole mind on the work until you finish it.

You can compel your mind to think of a single subject for many minutes or hours. A studious pupil will not notice the sounds and sights around him, and will forget his feelings of hunger and thirst while he is getting his lessons. Every person who has a strong mind has the power to keep his whole thought on a single thing for hours at a time. One of the principal things which you learn at school is how to think without being disturbed by what goes on around you.

Nervousness. — If a person cannot keep his mind on a single thing at a time, but is easily disturbed by what goes on around him, we say that he is *nervous*. Some persons suppose that what is called nervousness is a sign of a strong mind, because those who are nervous often take notice of slight feelings, sounds, and sights which most persons do not notice. No person can think well if he allows himself to be disturbed by

what he feels, or hears, or sees. Nervousness is not a help, but it is a great hindrance to thinking.

Many persons are nervous and irritable because they have not been taught habits of self-control. Some children are nervous because they are not trained to behave, and to put their minds to their work. Others are nervous because they really have something the matter with their bodies. Those who are sick, or tired, or in pain, are nervous because they do not feel well. The sickness gives them about all the unpleasant feelings that they can stand, and if an unpleasant sight or sound is added to their feelings, they become cross and fretful. A child who has a stopped-up nose, and has to breathe through his mouth, is likely to be cross and fretful, for he always has an uncomfortable feeling, and any discomfort added to that makes more than the child can stand.

Other common causes of nervousness in children are sitting up late at night, indigestion, improper eating, adenoids, and foul air. These things are also causes of ill health. Doing the things which make the body healthy and strong will often prevent or cure nervousness.

Joy of Health and Strength. — A person who is healthy will have very few feelings which make him think about his body. He will be able to use his arms, and legs, and all the rest of his body as he would a machine which is in perfect order. Almost the only uncomfortable feelings that he will have will be

hunger, thirst, weariness after work, and other feelings which tell him what his body needs. He will work hard for the pleasure of working, and will put forth his strength for the delight of using it. Children and young animals play until they are tired out, because the use of their strength is a joy to them.

A healthy grown person will enjoy life like a child. He will not notice the slight aches and pains which come while he works and plays, but he will enjoy trying his endurance and strength. Even his hunger and his tired feelings will not be unpleasant, for his eating, his rest, and his sleep will be among the greatest pleasures of the day.

Tired Nerve Cells. — When nerve cells work, they use up some of their own substance, as muscle cells do when they act. After a few hours of work they shrink in size and become unable to go on with their work. There is then a tired feeling like that which comes after muscular work. Nerve cells direct the actions of the muscles, and doing muscular work tires the brain as well as the muscles. Many of the tired feelings after exercise are due to tired nerve cells.

When a person thinks about a single thing day after day, the nerve cells which are in use do not get time to rest. A pupil who thinks about his examinations for hours and days does not allow his brain cells to rest, and he comes to his test tired out. A person who worries wears out his brain cells by thinking about his troubles during every moment. Any one who sticks

closely to only one kind of work without resting will finally ruin his health, for nerve cells need to rest and to store up food just as muscles need rest.

Rest for Nerve Cells. — A good form of rest for nerve cells is a change of work, for it brings a different set of nerve cells into use, and allows the tired cells to rest. A boy who studies hard all day will get brain rest by playing baseball after school, for his thinking cells will rest while he uses the nerve cells with which he directs his muscles. A bookkeeper who sits at a desk all day may get brain rest by tending a garden, or driving, or taking photographs. A tired business man will rest his brain while he drives an automobile for an hour or two at the close of the day.

If a person has no liking for play or pleasure, his mind will always be thinking about his work, and the nerve cells with which he does his work will get no rest. It is a good thing for every person to learn to like some kind of play or pleasure, for during playtime the working cells of the brain will rest.

Sleep. — The mind gets a complete rest during sleep, for then the nerve cells of the cerebrum seem to lose their connection with the rest of the body. But the spinal cord and the medulla act as perfectly while a person is asleep as while he is awake. The object of sleep is to allow the nerve cells of the cerebrum to repair their worn-out parts and take a new supply of food.

Every person must have sleep. He can go without

food longer than he can go without sleep. One of the first signs of danger from overworking the mind is trouble in sleeping. This is because the nerve cells have formed such a habit of working every moment that they cannot stop working when the person lies down at night.

Muscular relaxation is necessary for mental rest and sleep (p. 89). A person who is nervous or restless usually has some of his muscles contracted, because the motor cells of his brain are as active as the thinking cells. Practicing complete muscular relaxation is a great help in causing sleep.

While the brain is at work, a large quantity of blood flows through it, but during sleep it contains only a little blood. One of the principal things which prevent sleep is too much blood in the brain. When you cannot fall asleep, you can often hear your pulse in the ear which lies on the pillow. Anything which will cause the blood to leave your brain will help you to fall asleep. Soaking your feet in hot water will cause the blood to flow to your feet and away from your brain. Eating a light lunch will cause the blood to flow to your stomach. Having some one rub your back will cause the blood to flow to the muscles of your back. Listening to some one reading a dull book will keep you from thinking about your work, and the blood will then leave your brain, and you will feel drowsy. These are some simple things which will help you to fall asleep.

Mental Defects. — Some persons have brains that do not act properly on account of injury or disease. These are persons of unsound mind, and include the *feeble-minded*, the *mentally infirm*, and the *insane*.

The Feeble-Minded. — The minds of many children stop developing at too early an age. The *mental age* of a feeble-minded person is the age at which a normal person has the mental development of the one who is defective. A person who has the mind of a one-year-old baby is called an *idiot;* of a four-year-old child, an *imbecile;* and of a child from five to fourteen years old, a *moron*. The mental age of a backward child can be determined by an examination, or mental test, similar to that by which a teacher determines the proper grade to which a pupil belongs.

Many backward children are bright in certain subjects. Some have great talents for music, and others for making things with their hands. Many schools have special classes in which backward children are trained for earning their living.

The Mentally Infirm. — The brain, like a muscle, loses its power in old age. Those who are mentally infirm on account of age, and who have no means of support, are given care in almshouses.

The Insane. — An insane person can usually do most mental acts in a proper way, but he is likely to act disorderly and to injure himself and others; and so he requires care and watching.

Many persons with disordered brains would not

have become insane if they had not overworked their brains. After constant worry or weeks of work upon a single object, the brain may be unable to change its thoughts or direct them to other objects. A person with such a brain is insane. Vacations, and play between the hours of work, would prevent many persons from becoming insane.

Care of the Insane. — If a person has an injured arm, the principal thing to do for it is to give it entire rest until it can grow strong again. The principal thing to do for an insane person is to prevent his brain from doing those acts which it cannot do properly. This can be done in the best way by taking the person away from his home and his work, and placing him in a hospital where new thoughts will fill his mind. Most insane persons improve, and many recover, within a few weeks or months after they enter a hospital.

Alcohol and the Brain. — One of the principal effects of alcohol on the body is to poison the nerve cells of the brain. This is what is meant when it is said that drink goes to the head. The most common form of the poisoning is drunkenness (p. 61).

When a person drinks, the first nerve cells to be poisoned are those with which thinking is done. One of the first signs that a man is getting drunk is that he talks without thinking how his words sound. This poisoning begins soon after the alcohol is taken.

The next brain cells to be poisoned are those by which the muscles are moved. In this stage of drunk-

enness a person cannot walk straight or talk clearly.

The next brain cells to be poisoned are those by which messages are received through the senses. The drunken person then knows nothing, but lies as if in a deep sleep. The alcohol may also poison the cells in the lower part of the brain, and life is then in danger, for these cells control the breathing and the heart.

In olden times men used to have contests to see who could drink the most liquor. It was thought that the winner would be the coolest and most thoughtful person in times of accident or danger, for if alcohol did not upset his thoughts, it was supposed that nothing else would upset them. The alcohol often dulled his mind and thoughts, and the drinker would then perform daring acts. The reason why alcohol seemed to make men brave and cool was not that it helped them to think, but that it kept them from thinking clearly.

If alcohol really made men brave and thoughtful, it would be given to firemen when they go to dangerous fires. But one of the strictest rules in all fire departments is that the men shall not drink, for the kind of thoughtless daring produced by alcohol is dangerous both to the firemen themselves and to those whom they would try to save.

Effects of Light Drinking. — After the brain cells have been slightly injured over and over again, they cannot recover from the harm. Taking alcoholic

liquors injures the mind, even though not enough alcohol is taken at any one time to produce drunkenness. The first signs that a drinker is harmed are usually shown by his carelessness in his work. Drinkers lose their keenness of judgment, and often make mistakes in their work. If a drinker were the cashier of a bank, he would be likely to add columns of figures wrong. Railroad managers will not allow a drinking man to have anything to do with running trains.

Alcohol and Poverty. — The use of alcohol often makes men poor. They lose good positions because they are not able to do their work well. They spend their money for drink instead of for food, and clothes, and houses. A place where the effects of drinking may be seen is an almshouse, where poor persons who are too weak to work are supported at public expense.

Alcohol and Crime. — Another place where the effects of drinking may be seen is a prison. Many criminals take whisky to make themselves daring enough to commit their crimes. Others commit crimes because the drink takes away their thoughts and prevents them from seeing the evil of their acts. Alcohol has long been regarded as one of the great causes of crime.

Alcohol and Insanity. — A third place where the effects of steady drinking may be seen is a hospital for the insane. Alcoholic drink is a common cause of insanity. Many insane persons are the children of

drinking parents, and were born with weak minds because of their parents' drinking.

Cigarettes and the Mind. — The use of tobacco hinders the growth of the cells of the brain. Tobacco is a narcotic to the nerve cells of both the old and the young, but it is a far worse poison to young persons than to grown persons, because it prevents the nerve cells from growing. Very few boys who smoke cigarettes stand well in their classes at school. Nearly all boy criminals use cigarettes. Most of the idle boys who stand on street corners are cigarette smokers.

QUESTIONS

Into what three parts is the brain divided?

What is the size and shape of the medulla?

What is the use of the medulla?

Why is the medulla sometimes called the seat of life?

Where is the cerebellum situated?

What is the use of the cerebellum?

Where is the cerebrum situated?

What is the size of the cerebrum?

Where is the gray matter of the cerebrum?

Of what use are the folds on the surface of the cerebrum?

What part of the brain does the conscious work of the mind?

What are the three principal kinds of work which are done by the nerve cells of the cerebrum?

In what part of the cerebrum are the nerve cells with which a person feels, sees, and hears?

In what part of the cerebrum are the nerve cells which send orders to the voluntary muscles?

What is memory?

What takes place in the brain when a person thinks?

In what part of the cerebrum are the nerve cells with which thinking is done?

What happens to nerve cells when the mind is trained?

What is a *habit?*

How are good habits formed?

How may bad habits be overcome?

What is nervousness?

What are some of the causes of nervousness?

How do tired nerve cells differ in appearance from rested cells?

How does a change of work help to rest nerve cells?

What makes nerve cells tired during muscular exercise?

Of what value is play to a business man?

What is the use of sleep?

What are some of the reasons why a person sometimes cannot fall asleep when he lies down at night?

What are some of the things which will help a person to fall asleep?

What effect does light drinking have on a person's mind?

What effect does drinking have on a person's getting employment?

What effect does drinking have on a person's power to earn money?

What effect does drinking have in causing crime?

What effect does drinking have in producing insanity?

What effect does tobacco have on the brain cells of young persons?

For the Teacher. — The object of this chapter is to explain the simplest elements of the physical basis of mental action. The work of the medulla is almost like that of the spinal cord; and that of the cerebellum is the coördination of muscular movements. The distinctive work of the cerebrum is that of carrying on conscious mental actions.

The principle underlying the elementary actions of the cerebrum is that of the localization of brain actions. In a general way the three elementary divisions of mental actions are the sensory, the motor, and that of thought. The motor area of the brain is definitely mapped out, but the sensory area is less definitely known. While most of the front part of the brain is concerned in thought, yet all parts are connected in an intricate way, and the processes of thought enter into the actions of the motor and sensory areas. This explains why training the muscles and the organs of special sense is excellent mental training.

Brain cells may be trained to act in as certain a manner as muscle cells, and they are subject to the same disorders that affect the cells of other parts of the body. Practical applications of these principles are given under the topics of habits, mental concentration, brain fatigue, and perverted mental action.

CHAPTER XXXI

THE SENSES

Use of the Senses. — The principal nerve messages of which a person is conscious are those which are received through the senses (p. 365). They consist of messages of touch, smell, taste, hearing, and sight. Their principal uses are to give the mind a knowledge of what goes on outside of the body, and to warn a person about his safety and comfort.

Touch. — The sense of touch is produced by the pressure of objects upon nerves that lie just beneath the epidermis of the skin (p. 189). If the epidermis is removed, anything that touches the bare spot produces a feeling of pain or smarting.

The sense of touch gives the mind a knowledge of the size, shape, hardness, smoothness, weight, and warmth of objects which touch the skin. The parts of the body in which the sense of touch is the keenest are the ends of the fingers and the tip of the tongue.

One way of testing the sense of touch is to press upon the skin on different parts of the body with the sharp points of a pair of compasses. The skin of the back will seem to feel only a single point if the tips of the compasses are separated two inches. The ends of the

fingers can feel that the points are separated if the points are only one eighth of an inch apart.

Weight. — A person judges the weight of an object in two ways: first, by the feeling of touch and pressure which the object gives when he holds it in his hand; and second, by the feeling which he has in his muscles when he lifts it.

Use of Pain. — Pain is a useful sensation because it is a message that some part of the body is in danger. If you could not feel pain, you might be seriously injured or even be killed before you knew of the danger. The pain of a decaying tooth will drive you to a dentist for relief, but an abscess along the root of a tooth often gives no pain, while its poisons may spread through the body and produce heart disease before you are aware of the tooth trouble.

False Messages. — The nerves of feeling go from the skin to the spinal cord, and then to the brain. If a nerve is wounded anywhere in its length, the feeling seems to be at its outer end, and not at the place where it is hurt. What is called the *funny bone* is a nerve which lies just above the inner side of the tip of the elbow. If it is pinched at the elbow, there is a feeling of pricking and smarting in the little finger where the nerve starts.

If a person sits with the legs hanging down from the edge of a chair, the feet often tingle and feel heavy and "asleep," because the nerves which go from them to the spinal cord are pinched at the knee. At

the beginning of hip-joint disease the pain is usually felt in the knee, and in appendicitis the pain often seems to be over all the lower part of the body. The part in which a pain is felt is not always the part which is out of order.

Training the Sense of Touch. — You can train the sense of touch by use. Surgeons train their finger tips in the examination of parts which lie deep in the body. Blind persons learn to read by passing their finger tips over raised letters. When you train your sense of touch, you train the nerves under the skin to receive slight impressions. You also train the cells of your brain to recognize slight differences in the messages which they receive. Training the sense of touch is excellent mental training.

Smell. — Tiny bits of matter are always passing into the air from everything which has an odor. When these bits of matter touch the nerves of the nose, they give rise to a message which the brain receives as a smell. By means of the sense of smell a person can judge of the purity of food and air. Dogs, and some other lower animals which have a keen sense of smell, depend upon it as much as persons depend upon the sense of sight.

Taste. — When a substance which has a taste is taken into the mouth, some of it dissolves in the saliva and soaks through the epidermis. When it touches the nerves of the tongue, it gives rise to a message which the brain cells receive as a taste. The sense of taste

enables a person to judge something about the purity and wholesomeness of food. The taste of food also has a great effect on the flow of gastric juice, and on the digestion of food (p. 263).

A person judges the tastes of sweetness and sourness by means of the nerves in the front part of the tongue. He judges bitterness and saltness by means of the nerves in the back part of the tongue. He judges the taste of spices largely by means of particles which rise to the nose and there produce an odor. A person who has a cold in the nose loses a part of his sense of taste, because of the hindrance to his sense of smell.

Hearing. — One way in which a person learns about objects which do not touch the body is by means of air waves which are set in motion by the objects when they vibrate rapidly. These air waves, striking the nerves of the ear, produce the messages which the brain receives as sounds. Loud sounds are caused by strong air waves which are sometimes felt with the nerves of the skin, but the only waves which are heard are those which strike the nerves of the ears.

The Ears. — The ear consists of three parts, called the outer ear, the middle ear, and the inner ear.

The outer ear consists of two parts: first, the shell, which is usually called the ear; and second, a tube which extends from the shell of the ear about an inch into the side of the head. The bottom of this tube is closed by a thin sheet of flesh, called the *eardrum*, which is like the head of a drum.

A space called the middle ear is hollowed out of hard bone behind the eardrum. The middle ear is filled

PHOTOGRAPH OF THE INNER PARTS OF THE HUMAN EAR

(Natural size.) They are surrounded by solid bone which has been cut away below the dotted line. *a*, eardrum; *b*, bones of middle ear; *c*, inner ear.

with air, and contains a chain of three small bones extending across it from the eardrum to a smaller drumhead on the opposite side.

A small space called the inner ear is hollowed out of the hard bone behind the inner drumhead. The inner ear is shaped like a snail shell and is filled with a liquid in which the nerves of hearing lie.

How a Sound Is Heard. — Air waves strike the eardrum, and cause it to move back and forth. This moves the bones of the middle ear, and they produce waves in the liquid of the inner ear which strike the nerves of hearing. The nerves carry a message of the motion to the brain, and the brain cells receive the message as a sound.

Deafness. — If a person cannot hear well, we say that he is *deaf*. Deafness is nearly always caused by some trouble in the middle ear.

A tube called the *Eustachian* (ū-stā′kĭ-an) *tube* extends from the middle ear to the throat. If you hold your nostrils closed, and try to blow hard, you will

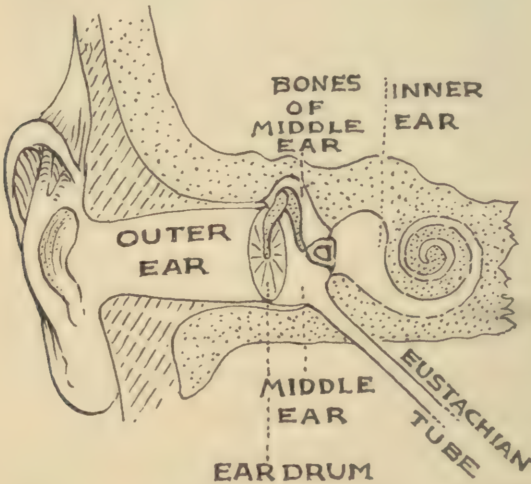


Diagram of the Ear

force air into the middle ear. You will then feel a buzzing in your ear, and will not be able to hear well, for the pressure of the air will keep the eardrum from moving freely. When you swallow, you open the tube and let the air out of the middle ear, and you can then hear well again.

Most deafness is caused by throat trouble which stops up the Eustachian tube. For this reason ade-

noids are often the cause of deafness. Most children who are deaf have adenoids, and the removal of the adenoids will nearly always help their hearing (p. 143).

Running Ears. — Sometimes a soreness and swelling in the throat extend up the Eustachian tube into the ear. The ear then becomes filled with a thick liquid, like that which is coughed from the throat. This liquid presses upon the eardrum and causes an earache. If the drum bursts, the pain will stop as soon as the matter runs out. But some matter will often keep on running from the ear for days and weeks afterward.

A child who has earache and running ears is nearly always deaf. Most of these children may be made well, and their deafness cured, by a skillful physician.

Testing the Hearing. — Many children seem to be dull and careless at school because they are slightly deaf and do not hear what is said to them. In many schools the hearing of every pupil is regularly tested.

A good way to test a person's hearing is to stand about ten feet away from him and whisper numbers for him to repeat. In this way you can find out how loud a sound he can understand. Test each ear separately while the other ear is closed.

A person with good hearing will be able to understand a loud whisper in a quiet room about twenty-five feet away from his ear. If he can understand a loud whisper no farther away than five feet, his hearing is only one fifth as good as it should be. It is a good plan for a person with good hearing to stand beside the one

whom you are testing, so as to compare the hearing of the two.

Training the Hearing. — Most sounds are made up of many separate sounds. The sound of the music made by a singing class is made by a number of persons, and a trained musician can pick out the sound of each separate voice. The same sounds fall upon the ears of all who listen to the music, but the trained person will notice differences between sounds which seem alike to untrained persons. Training the ears is really training the brain to notice slight differences in the messages which the ears send to the brain.

Injuries to the Ears. — The middle ear and the inner ear are hollow spaces deep in a hard bone of the skull, and are seldom injured except by blows which injure the whole skull. Almost the only way by which one is likely to injure an ear is to thrust something against the eardrum. Picking the ears in a careless way, or putting things into the outer ear in fun, may injure the eardrum. Slapping or boxing the ears may also injure the eardrum by producing a sudden pressure of air upon it.

Earwax. — A brown wax is formed by the skin which lines the outer half of the tube of the outer ear. The use of the wax is to protect the lining of the outer ear. The epithelium of the skin grows outward and carries the wax with it, and there is seldom need to pick the wax from the ears. If it should collect, it may be removed safely by means of the loop of a fine wire hairpin.

QUESTIONS

What are the *senses?* Of what use are they?

In what part of the body is the sense of touch produced?

In what part of the skin is this sense the keenest? How can you test its keenness?

What sense do blind persons use when they read?

How do you judge the weight of an object?

Explain the unpleasant feeling which you have in your little finger when you pinch your funny bone.

Explain the feeling which you have in your foot when it is "asleep."

How is the sense of smell produced? Of what use is it?

How is the sense of taste produced? Of what use is it?

What kinds of taste do you judge with the front part of your tongue? with its back part?

How does the sense of smell help you to judge the taste of an object?

How does a bell or other object produce a sound?

Of what does the outer ear consist?

What are the principal parts of the middle ear? of the inner ear?

How does sound travel from the outer ear to the nerves of hearing?

What is the Eustachian tube?

How does throat trouble produce deafness?

How do adenoids produce earache?

How can you test the hearing of a person?

How does brain training help the hearing?

How may slapping the ears injure the hearing?

How may earwax be removed from the ears with safety?

For the Teacher. — Children are often heedless and inattentive because they are partly deaf and neither they nor their parents are aware of the defect. Test the hearing of every pupil in the room, and pay special attention to those who are even slightly deaf.

If a child has a running ear or other form of ear trouble, try to get his parents to secure the proper treatment for him, for he is not likely to "outgrow" the defect. Many forms of deafness may be improved or cured by proper treatment.

Emphasize the object of pain, and the necessity of heeding its warning, by going to a physician in order to have its cause determined and removed.

CHAPTER XXXII

THE EYE

Importance of Sight. — The principal way by which we learn about an object which is beyond the reach of our hands is by means of light which comes from it to our eyes. Few persons could carry on their daily work if their sight were suddenly taken away.

The Eyeball. — The framework of the eye is a thick and tough shell called the *eyeball*. The eyeball is shaped like a hollow globe, and is filled with a clear liquid. It is white, except its front part, which is clear like glass, and is called the *cornea* (kôr′nė-ȧ).

The Iris. — The eyeball has a dark-colored lining, called the *choroid* (kō′roid) *coat*, which is about as thick as writing paper. The front part of this lining hangs like a curtain behind the cornea, and is called the *iris* (ī′rĭs). The color of the iris is usually some shade of blue or brown. It shows through the cornea, and gives the eye its blue or brown color.

The Pupil. — In the center of the iris there is a round hole, called the *pupil*, through which light enters the eye. The pupil appears black because the inside of the eye is dark in color. The iris contains muscles

which regulate the size of the pupil. A strong light causes the muscles of the iris to contract and make the pupil small in order to shut out some of the light. When the light is dim, the muscles relax and the pupil becomes large so as to admit as much light as possible. The pupil of a cat's eye is only a narrow slit in the daytime, but at night it is a large, round hole which admits much more light than the pupil of a person's eye. For this reason a cat can see at night better than a person.

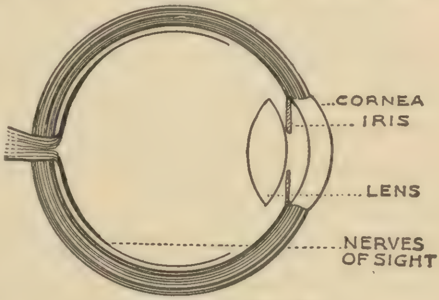


DIAGRAM OF THE EYE

The Lens. — A rounded piece of tough flesh, called the *lens*, lies just behind the pupil. It is as clear as glass, and its front and back faces are curved like the faces of a small magnifying glass. Its use is to bend rays of light in such a way that they come together upon the back of the eyeball, and there form a picture of objects which are in front of the eye.

The Retina. — A large nerve called the *optic* nerve enters the back part of the eyeball and spreads over the choroid coat. This coating of nerves is called the *ret'ina.* When light falls upon the retina, its nerves carry a message of sight to the brain.

The Eye Like a Camera. — An eye is like a photographer's camera. The eyeball is like the camera

box. The choroid coat is like the black paint with which the inside of the camera is coated. The cornea and the lens are like a double lens in the camera. The retina is like the plate on which the picture is formed.

Focusing the Eye. — When a photographer takes a picture, he moves the lens back and forth until the image is distinct upon the back part of the camera. If the image of a distant object is distinct, the image of an object near the camera will be blurred. Adjusting a camera to make a distinct image of an object is called *focusing*.

The eye is naturally focused to form a distinct image of an object which is over twenty feet away. When a person looks at an object which is nearer than twenty feet, muscles inside the eyeball make the lens more curving or bulging, in order to form a distinct image upon the retina.

Reading often tires the eyes, because the muscles of the eyes have to act upon the lens in order to form clear images of the print. When your eyes become tired from study, you may rest them by looking at the view from a window, for the muscles which focus your eyes are at rest while you look at distant objects.

Blurred Sight. — A person who has good sight can focus his eyes to see an object which is only six inches away. Some persons can see distant objects clearly, but their eye muscles are unable to make the lens curving enough to see objects close by. These persons are called *farsighted*. The lenses of their eyes are not suffi-

ciently curved. Most persons become farsighted after they pass the age of forty years.

Some persons cannot see distant objects clearly, but have good sight for objects which are held only a few inches from their eyes. These persons are called *near-sighted.* The lenses of their eyes are too curving.

Sometimes the lens or the cornea is not perfectly curved, but is irregular in shape. Objects then appear blurred. This trouble is called *astig'matism.*

Use of Spectacles. — Farsightedness, nearsightedness, and astigmatism may all be helped by the use of spectacles, for the roundness of the glasses will correct the faults in the roundness of the lenses of the eyes. Proper glasses will not harm the eyes in any way, but they will strengthen the eyes, and will keep the sight from failing. Going without glasses when they are needed is often a cause of weak eyes and headaches.

Spectacles that are held in place by bows over the ears are more comfortable than eyeglasses that are held in place by springs fastened to the nose. If children wear eyeglasses, the pressure of the springs may hinder the growth of the bones of their noses.

No one can see well through dirty glasses. If you have to wear glasses, keep them clean.

If the spectacles are set crooked on the nose, the eyes will ache from trying to look through them. If they will not stay in place squarely in front of the eyes, bend their frames or bows so that they will fit the eyes.

Cross-eyed Sight. — The eyeball may be turned or rolled in every direction by means of six muscles. The eye must be turned directly toward an object in order to see it clearly. If a person's two eyes are not turned equally toward an object, two images of the object will be seen. The person is then said to see double, and to be *cross-eyed.*

Some persons have double sight only when their eyes are tired. Slight forms of double sight are often the cause of severe headaches. Cross-eyed sight and the headaches resulting from it may be relieved by a good oculist.

Signs of Poor Sight. — Many persons have poor sight and do not know it. Many children seem to be dull at school because they cannot see well. Many children are born with poor sight, and no one finds it out until the children go to school.

One of the principal signs of poor sight is a headache which comes on after using the eyes. The cause of the headache is a pain in the muscles of the eyes.

Another sign of poor sight is a blurring of the sight after the eyes are used for some time. The cause of the blurring is the tiredness of the eye muscles from the constant strain of focusing or turning the eyes.

Testing the Sight. — Cards for testing the sight may be obtained at most jewelry stores. They bear large letters of various sizes clearly printed on cardboard. Test a person's eyes by placing one of the cards about twenty feet away, and have him read as many of the

letters as he can. The following table gives the distances at which a person with good sight should be able to read letters of various sizes.

Height of letter	Distance at which it may be read
$3\frac{1}{2}$ inches	200 feet
$1\frac{3}{4}$ inches	100 feet
$1\frac{1}{4}$ inches	70 feet
$\frac{7}{8}$ inch	50 feet
$\frac{3}{4}$ inch	40 feet
$\frac{1}{2}$ inch	30 feet
$\frac{3}{8}$ inch	20 feet

TESTING THE EYESIGHT

Cover one eye while testing the other.

A person's sight may be recorded in the form of a fraction in which the numerator is the distance of the person from the card, and the denominator is the distance at which the smallest letters which he reads should be read by a person with good sight. For example: If a person stands 20 feet from a card, and the smallest letters which he can read are $\frac{3}{4}$ inch high, he sees only $\frac{20}{40}$, or $\frac{1}{2}$ as well as a person who has good sight.

If your sight is not good, go to an oculist and let him test your sight and fit you with glasses. Most persons

who have poor sight are able to see well when they wear the right kind of spectacles.

How the Sight Is Injured. — Many children are born with an eye weakness which becomes worse after straining the eyes and using them improperly. The most common causes of harming the eyes are a wrong light and a wrong position in reading or working.

READING BY LAMPLIGHT

Sit with your left side toward the light. Hold your book squarely in front of your face.

Wrong Lighting. — A bright light shining into the eyes causes their muscles to contract so as to shut out the light. The muscles constantly pulling upon the eyeballs may press them out of shape and cause blurred sight.

Reading in a dim light tires the muscles of the eyes, for when the sight is not good, the muscles keep trying to focus the lenses. A light is of the proper strength when it is agreeable to your eyes.

The best position for the light is at your left side, for it then does not shine into your eyes, and your right hand does not shade your work.

Improper Position in Reading. — When you look directly forward, the muscles which move your eyes are at rest. When you turn your eyes up, or down, or sidewise, the muscles flatten the eyeball as they pull upon it, and prevent you from seeing distinctly. When you read, place your book squarely in front of your face in order that your eye muscles may have as little work to do as possible. When you study at a table, have the top of your book raised, in order that the pages may lie squarely before your eyes while you sit upright.

Reading while lying down tires your eyes, for you then have to turn your eyes downward toward your feet. When you read on a railroad train, your book shakes, and your muscles soon become tired in keeping your eyes turned toward the page.

Injuries to the Eye. — The eye is set deep in a bony socket which protects it from blows. It lies upon a bed of fat which acts like a spring and allows it to slip about when it is jarred or struck. The outer shell of the eyeball is as thick and tough as sole leather, and can scarcely be cut with a sharp knife. An eye is seldom

injured by accident except by shot or by sharp instruments which strike it directly in front.

Sometimes the skin around the eye is made purple or black by blows over the eye. The color is seldom in the eye itself, but is in the bruised skin around the eye.

Dirt in the Eye. — The eye is covered with two movable lids which protect it from dust and slight injuries. The surface of the eye is moistened with a fluid, called *tears*, which is produced by a gland lying just above the eyeball.

The eye is very tender, and becomes painful when there is a speck of hard dirt between the lids and the eyeball. If you have a bit of dirt under an eyelid, do not rub the eye, for the rubbing makes the dirt scratch the eye. Grasp the eyelashes, and hold the lid away from your eyeball for a moment. The tears may then wash the dirt away. If the dirt does not come away, let a friend lift the eyelid and brush the dirt away with the corner of a clean handkerchief.

Sore Eyes. — The most common cause of sore eyes is the growth of disease germs under the eyelids and on the eyeball. The germs make the eyes red, and cause them to smart and to ache. Many kinds of eye diseases are infectious, and are caught from other persons who have sore eyes.

Do not use a towel or handkerchief which has been soiled by any one with sore eyes. If you have sore eyes, use your own towels and handkerchiefs, and boil them when they are washed. You can help to cure

sore eyes by washing them often with warm water so as to remove the germs.

The eyes of babies are often injured by house flies crawling over them. Drive the flies from the room where a baby is to sleep, or cover it with mosquito netting in order to prevent flies from crawling over its face.

One form of sore is called *granulated lids*, or trachoma (trȧ-kō′mȧ). It is very infectious, and is becoming common in some places. If it is not properly treated, it becomes worse and worse, and often destroys the sight. But it may readily be cured by a doctor.

Training the Eye. — When you look at an object, images of everything in front of your eyes are formed on their retinas, but the brain takes notice of only the images which you wish to see. For example, if you look at a bird in a tree, images of the bird, the tree, and the sky are all formed in your eyes, but your brain takes notice of the image of the bird only.

When you look carefully at an object, the thing which you wish to see is often the dimmest and most blurred part of the object. You can train your brain to notice and recognize dim and blurred images that scarcely make an impression on the eye at all. For example, a sailor, seeing a dim speck miles away on the water, can tell whether or not it is a ship, and what kind of vessel it is. Training the eyes is really brain training. Any person who has fair sight can train his brain to see things which an untrained brain will not notice at all.

Tobacco and the Eyes. — Tobacco sometimes injures the nerves of the eyes, and produces blindness. Smoking is more likely to injure the eyes than the use of tobacco in any other form. The blindness usually passes off when the use of the tobacco is stopped.

QUESTIONS

Describe the eyeball, and name its principal parts.

Of what use is the iris?

Of what use is the lens?

In what respect is the eye like a photographer's camera?

How is the eye focused?

What is *farsightedness?*

What is *nearsightedness?*

What is *astigmatism?*

How do spectacles help the sight?

Why are spectacles with bows more healthful than eyeglasses that pinch the nose?

What is the cause of double sight?

What are some of the signs of poor sight?

How does poor sight cause a headache?

How can you test the sight?

How does a wrong light injure the eyes?

How does reading on a railroad train tire the eyes?

What position of the body and arrangement of the light are the most comfortable for the eyes?

How is the eye protected from injury?

Of what use are tears?

Why is it harmful to rub an eye when there is a speck of dirt in it?

How can you remove dirt from under an eyelid?

Name some ways in which soreness of the eyes may be spread from one person to another.

What is *trachoma?*

How can you train your eyes to see faint and indistinct objects?

What effect does tobacco have upon the sight?

For the Teacher. — It is scientifically correct to compare the eye with a camera.

The most common eye defect is that of the lens. Most forms of lens trouble may be corrected by the use of the proper glasses. Many persons object to wearing them because they say that when a person begins to wear them his sight becomes worse after he leaves them off. It often happens that a person who has always had blurred vision first fully realizes his defect when he loses his glasses and is compelled to see things blurred again.

Focusing the lens and directing the eye toward objects are muscular actions. Fatigued eye muscles are often the cause of headaches in persons who have to put forth considerable effort to see clearly. Test the sight of every pupil that has frequent headaches.

A teacher who has no standard test card can test the vision by the following method: Take a newspaper having type of various sizes and place it in a good light. Place yourself and the pupil to be tested about three feet in front of the paper and have the pupil pronounce letters, beginning with the largest. See if the pupil can recognize letters which are as small as those which you can read.

Try to influence the parents of children with defective vision to secure the proper glasses for their children or treatment for them.

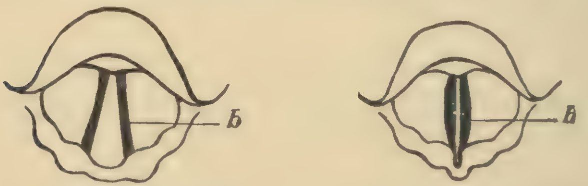
Some forms of soreness of the eyes are contagious, some are caused by unclean habits, and some by eyestrain. It is always proper to advise children with sore eyes to cleanse them twice a day with warm water in which borax is dissolved. If the cleansing does not improve them in a few days, try to have the parents secure medical treatment.

CHAPTER XXXIII

THE VOICE

Vocal Cords. — The sound of the voice is made in a box, called the *lar′ynx* (lăr′ĭngks), which forms the uppermost part of the windpipe. The front upper corner of this box forms the lump called the Adam's Apple, which may be felt in the front of the neck just below the chin.

Two white bands of flesh, called *vocal cords*, are tightly



Cords open and at rest — Cords closed and in action

DIAGRAM OF VOCAL CORDS (*b*)

stretched backward across the top of the larynx. When the cords are tightened and brought close together, and air is forced between them, they tremble back and forth and make a sound in the same way that blowing through a tin horn produces a noise. The sound made by the vocal cords alone is unpleasant and squeaking, but it is increased in power and

made pleasant by means of the nose, mouth, tongue, and teeth.

Speech. — When a sound is made in the throat, the lips, teeth, and tongue may change the air current in such a way as to form the sounds of letters and words. You form the sound of *B* by starting with your lips closed, and suddenly forcing them open with a blast of air which passes through the vocal cords. You form the sound of *D* by starting with the tip of the tongue against the front part of the roof of the mouth. When you whisper, you do not use the vocal cords at all, but make use of the sound produced by blowing air through the lips.

Speech Defects. — Some boys and girls who do not pronounce their words plainly suppose there is something wrong with their lips or tongue. This is almost never so. The reason why they do not talk distinctly is because they have not learned to move their lips and tongue correctly. They can learn to speak distinctly if they will notice the correct positions of the tongue and lips in pronouncing difficult words, and will then practice speaking the words clearly.

A person who cannot talk is said to be *dumb*. A baby learns to talk by hearing the speech of other persons. The reason why dumb persons cannot talk is that they are deaf and do not know what words sound like. There is seldom anything the matter with their noses and throats, and they learn to talk when they are shown how to place their lips and tongues in order

to form words. Children who are totally deaf soon learn to talk when they are sent to a school for the deaf and dumb.

Stammering and stuttering are usually the result of nervous affections and may be prevented or cured by patient training in pronouncing words, and in reading and speaking.

Singing Is a Good Form of Exercise for the Voice

Exercising the Voice. — The sound of the voice is formed by means of muscles. If boys and girls do not use their voice muscles, they will grow up with weak voices, and will be unable to sing or speak with strong tones, or for many minutes at a time.

You can make your voice muscles strong by exercising them, just as you make the muscles of your arm strong by use. A good form of voice exercise is to read aloud at home in the evening.

If you use your voice muscles until they are overtired, you will make them weak, just as overworking

your arm muscles will make them weak. Some of the ways in which boys and girls are liable to injure their voice muscles are by loud shouting, singing for a long time, and long cheering at games.

A young boy's voice sounds like a girl's voice, but at about the age of fifteen his larynx suddenly grows faster than his body. This growth produces a change in his voice, by which it becomes low-pitched and deep, like a man's voice. While this change is taking place, the voice muscles may be strained more easily than at any other time.

A Pleasing Tone of Voice. — You like to hear some persons talk, because their words sound like music. The voices of others are loud, or shrill, or whining, or have some other unpleasant tone that makes you feel uncomfortable. A voice with an unpleasant tone keeps you from resting and increases your discomfort when you are sick. The tone of voice with which you usually speak will have a great effect upon the health and comfort of others.

You can form a habit of speaking with a pleasing tone if you try to do so. To speak always in a pleasant and distinct tone of voice is one of the most pleasing habits that you can form.

QUESTIONS

Where is the sound of the voice made?
Describe the larynx.
How do the vocal cords produce sound?
What organs do you use when you pronounce letters and words?

How do you form the sound of *B*? of *D*?

How can you improve the distinctness of your speech?

What is the cause of dumbness?

How may a deaf and dumb person be taught to speak?

Name some ways in which the tone of the voice may affect a person's health.

How can you exercise the voice?

Name some ways in which the voice may be strained.

What causes the change of voice in boys? What is this change?

For the Teacher. — Defects of speech are seldom due to tongue-tie, or other defect in the mouth, but they are usually the result of careless habits of pronouncing words. Speech is made by muscular action, and some persons have lazy habits of speech just as they have of posture and the performance of other acts involving the use of muscles.

The tone of one's voice has a great effect on the comfort of other persons. No one likes to hear a voice that is loud, harsh, or shrill, but the habit of speaking in low-pitched, pleasing tones can be easily acquired.

GLOSSARY

Absor′bent cotton, sheets of cotton, free from oil and dirt, and especially prepared for dressing wounds.

Absorp′tion, the taking of food from the intestine by the blood.

Ace′tic acid, the sour substance in vinegar.

Ad′enoids, soft growths of flesh in the back part of the throat behind the nose.

Adultera′tion, the mixing of a cheap substance with a valuable one in order that the mixture may closely imitate the valuable substance.

Al′cohol, a colorless liquid used in manufacturing. It is the intoxicating element in beer, wine, whisky, and other strong drinks.

Al′ga, one of the simplest kinds of plants.

Am′ino acid, digested protein.

Anat′omy, the study of the structure of the body.

Antitox′in, a substance that will destroy the poisons which are produced by disease germs in the body. Antitoxins for diphtheria and lockjaw are in common use.

An′trum, the hollow space in the upper jawbone.

Aor′ta, the artery which carries blood away from the left side of the heart.

Ar′tery, a blood tube that carries blood from the heart.

Artific′ial respira′tion, making air pass into and out of the lungs in imitation of natural breathing.

Assimila′tion, making food into a part of the body, or putting food to use in the body.

Astig′matism, an unevenness of the surface of the cornea causing blurred sight.

Au′ricles, the two thin-walled cavities on the upper end of the heart.

Bacte′ria, the smallest known plants. Some cause decay, and others produce diseases.

Balanced diet, a bill of fare which supplies the body with the proper food substances.

Bandage, a dressing wrapped around a wounded part.

Bi′ceps, the muscle that lies on the front of the upper arm and bends the elbow.

Board of health, a body of officers who have charge of matters pertaining to public health.

Bot'ulism, a dangerous form of poisoning caused by eating spoiled canned food.

Bron'chi, the air tubes of the lungs.

Caf'feine, the stimulating substance in coffee and tea.

Cal'orie, the quantity of heat that will raise the temperature of four pounds of water very nearly one degree Fahrenheit.

Cap'illaries, the microscopic blood tubes that connect the arteries and the veins.

Carbohy'drates, starches and sugars.

Car'bon, a substance found in every living thing; charcoal.

Car'bon diox'ide, a gas formed by burning or oxidizing carbon.

Car'bon monox'ide, a poisonous gas produced by imperfect burning. It is in the exhaust gases of an automobile.

Carrier, a well person who produces disease germs in his body.

Car'tilage, tough flesh resembling softened bone; gristle.

Cells, the units of living matter in an animal or plant; the smallest bits of living matter which can carry on the processes of life.

Cerebel'lum, the rounded part of the brain under the hinder part of the cerebrum.

Cer'ebrum, the large rounded mass forming the upper part of the brain.

Certified milk, pure, clean milk produced under the oversight of a board of doctors.

Cesspool, an underground tank for receiving sewage.

Chlo'rine, a gas used in purifying water.

Cho'roid coat, the dark coat on the inside of the eyeball.

Circula'tion, the flow of blood through the body.

Coagula'tion, the process by which a liquid becomes jellylike; clotting.

Cold, any mild form of infectious disease.

Cold storage, the keeping of articles in a room artificially cooled in order to preserve them in a fresh state.

Connec'tive tissue, the tough fibers that hold cells in place.

Contact, a person who has been associated with a sick person or a carrier in such a way that he may have caught his disease.

Contrac'ture, a permanent contraction of a muscle.

Convul'sion, a contraction of all of the muscles of the body, due to sickness.

Cor'nea, the clear window in the front of the eyeball.

Cor'puscles, the cells that float in the liquid part of the blood.

Culture, an artificial growth of bacteria or other microscopic living things.

Decay', the process by which matter once living slowly goes to pieces and is finally returned to the soil and air. It is usually caused by bacteria or molds.

Der'mis, the true skin.
Di'aphragm, the sheet of muscle extending across the body near the waistline, and separating the chest from the abdomen.
Diges'tion, dissolving and changing food to forms that may enter the blood.
Diphthe'ria, a throat disease caused by the growth of diphtheria bacteria.
Disinfec'tant, a substance that will kill disease germs.
Dis'locate, to slip the ends of two bones of a joint past each other; to put out of joint.
Distilla'tion, separating alcohol from a boiling liquid by collecting the steam and cooling it.

Emul'sion, a milky liquid in which small drops of fat float in water.
Enam'el, the hard, white coating on the outside of a tooth.
En'zyme, a substance on which the digestion of food depends.
Epidem'ic, a disease that attacks a large number of people at once.
Epider'mis, the thin, outer covering of the skin, composed of epithelium.
Ep'ilepsy, convulsions due to a brain disease.
Epithe'lium, the cells forming the outer coating of the skin, the lining of the air tubes and digestive organs, and glands.
Esoph'agus, the tube that conducts food from the throat to the stomach.
Eusta'chian tube, the air tube leading from the throat to the middle ear.
Excre'tions, the oxidized substances and waste matters of the body.

Fermenta'tion, changing sugar in a liquid to carbon dioxide and alcohol.
Filter, a tank of sand used for removing impurities from water.
Fo'cal infection, disease germs which grow in a small part of the body for a long time and send mild poisons through the body.
Fo'cusing, changing the shape of the lens of the eye in order to see clearly.
For'malin, a colorless liquid used for killing bacteria and disease germs.
Frontal si'nus, the hollow space in the bone behind the eyebrows.
Funny bone, the nerve on the inner side of the tip of the elbow.

Gan'glia, collections of nerve cells in the sympathetic nervous system.
Garbage, waste food and other substances thrown away from the kitchen.
Gas trap, a portion of a waste pipe bent sharply in order to hold water and prevent sewer gas from flowing through the pipe.
Gas'tric juice, the liquid produced by the stomach to digest food.

Gland, a collection of tubes that remove substances from the blood, or form new substances out of the blood.
Gly'cogen, a form of sugar which is stored in the liver.
Goi'ter, an enlargement of the thyroid gland.

Hæmoglo'bin, the red coloring matter of the blood.
Hu'merus, the bone in the upper half of the arm.
Humid'ity, the wetness or dryness of the air.
Hy'drogen, a substance that forms a part of every living thing. Pure hydrogen is a gas, and forms water when it is burned.
Hydropho'bia, a disease of the brain usually caught from mad dogs; rabies.
Hy'giene, the study of the care of the body.
Hyster'ics, a mental sickness accompanied by much laughing or crying.

Idiot, a grown person who has the mind of a baby.
Im'becile, a grown person who has the mind of a four-year-old child.
Immu'nity, the ability of the body to prevent the growth of disease germs in the flesh or blood.
Incuba'tion period, the time that elapses between taking disease germs into the body and the onset of the sickness.
Infec'tion, the taking of germs of a disease into the body.
Infec'tious diseases, forms of sickness due to the growth of disease germs in the flesh or blood; diseases which one person can catch from another.
Insan'ity, a mental disease or disorder which causes the sick person to act in a disorderly manner.
Intem'perance, satisfying a false appetite.
Intes'tine, the part of the food tube below the stomach.
Intoxica'tion, a poisoning by alcohol.
I'ris, the colored curtain in the front part of the eyeball.
Isola'tion, keeping a sick person away from those who are well and have not had his disease.

Lac'teals, the lymph tubes that take digested fat from the intestine.
Lactic acid, the sour substance in sour milk.
Lar'ynx, the box of cartilage in which the sound of the voice is formed.
Lens, the part of the eyeball that forms clear images in the eye.
Lig'aments, the tough bands of flesh that bind the bones of a joint together.
Liver, the gland that manufactures bile.
Lymph, the liquid that passes from the blood through the sides of the capillaries to feed the cells of the body.
Lymphat'ics, the fine tubes that conduct lymph toward the heart.

Maggot, a young fly in its wormlike stage.

Medul'la, the part of the brain next to the spinal cord.

Metab'olism, the processes of upbuilding and destruction by which life is maintained in a living body.

Minerals, the part of the body that is left as ashes when the body is burned.

Molars, the double teeth.

Mold, microscopic threadlike plants that grow in damp places and often produce a velvetlike covering on food and clothing.

Mor'phine, the narcotic poison in opium.

Motor nerves, nerves that carry messages away from the brain or spinal cord.

Mu'cous membrane, the skinlike lining of the air passages and digestive tube.

Mu'cus, the substance, like white of egg, formed by mucous membranes.

Muscle, a bundle of cells that produce a motion of some part of the body; lean meat.

Narcot'ic, a drug that dulls the mind and produces sleep.

Nerve, a thread or string of flesh that carries messages between the brain or the spinal cord and another part of the body.

Nic'otine, the principal poisonous substance in tobacco.

Ni'trogen, the gas that forms four fifths of the air.

Nu'cleus, the dark-colored spot seen in most cells.

O'pium, the dried juice of a poppy plant. It is a narcotic, and produces sleep.

Organ, a part of the body which does a special kind of work.

Osmo'sis, the mixing of two liquids or gases when separated by a thin sheet of tissue.

Oxida'tion, the union of oxygen with a substance; burning.

Ox'ygen, a gas that forms one fifth of the air. It unites with other substances in a fire and other forms of oxidation.

Pan'creas, a gland that produces one of the digestive juices.

Pancreat'ic juice, the digestive liquid formed by the pancreas.

Panic, a fear that leads a crowd to act in a dangerous manner.

Papil'læ, the tiny projections that form lines and patterns on the skin, especially on the palms of the hands.

Par'alyzed, unable to move a part of the body.

Parame'cium, a microscopic animal composed of a single cell.

Pas'teurize, to heat milk or other substance to about 145° F. for about 30 minutes in order to kill the bacteria that it may contain.

Perios'teum, the skinlike covering of a bone.

Peristal'sis, the motions of the digestive organs by which food is forced down them.

Perspira'tion, sweat.
Phar'ynx, the muscular bag forming the back part of the throat.
Physiol'ogy, the study of the work of the body.
Plague, a dangerous disease that is spread mostly by fleas that infest rats.
Plas'ma, the liquid part of the blood; serum.
Pores, the openings of the sweat glands.
Pro'tein, the substance, like white of egg, that forms the living part of every plant and animal.
Proud flesh, new flesh growing on a sore spot faster than the epidermis can cover it.
Pupil, the round hole in the iris admitting light into the eye.
Pus, the creamy matter flowing from a wound. It consists mainly of white blood cells killed by disease germs.

Quar'antine, preventing the spread of an infectious disease by keeping the sick away from the well.

Ra'bies, hydrophobia.
Ra'dius, the bone on the thumb side of the arm below the elbow.
Re'flex action, the action of the brain or spinal cord made in response to a sensory message.
Res'ervoir, a very large tank in which water is stored.
Respira'tion, breathing and the oxidation in the body.
Ret'ina, the inner coating of the eyeball. It contains the nerves of sight.

Sali'va, the digestive fluid in the mouth.
Sanato'rium, a home in which unhealthy persons are taught how to live healthful lives.
Scarlet fever, an infectious fever in which there is redness of the skin, followed by a peeling of the epidermis.
Scrof'ula, a disease in which the lymph glands of the neck are enlarged.
Scurvy, a disease caused by the lack of fresh vegetables and fruits.
Seba'ceous gland, a gland which produces oil to soften the skin and hair.
Secre'tion, the substance formed by a gland.
Sen'sory nerves, the nerves that carry messages to the spinal cord or brain.
Septic tank, a tank in which the solid matters of sewage decay and are liquefied.
Se'rum, the liquid part of blood.
Sewage, waste water and slops from kitchens, laundries, and bathrooms.
Shock, sudden weakness or sickness due to an injury.
Skel'eton, the bony framework of the body.

Spinal cord, the part of the nervous system that is contained inside the backbone.

Spores, the seedlike particles of dust produced by molds and many other plants.

Spu'tum, thick mucus removed from the air tubes.

Ster'ilize, to heat a substance so as to kill the bacteria in it.

Ster'num, the breastbone.

Stim'ulant, a substance that acts upon the body like a whip.

Stomach, the enlarged part of the digestive tube that receives food after it has been swallowed.

Streptococ'cus, a common form of disease germ which produces severe forms of tonsillitis and other diseases.

Sympathet'ic system, the part of the nervous system that controls the action of glands and involuntary muscles.

Syno'vial fluid, the fluid contained in the joints.

Tartar, a brown crust that often forms on unclean teeth.

Tet'anus, a disease in which the muscles of the whole body are contracted; lockjaw.

Thermom'eter, an instrument for measuring degrees of temperature.

Tho'rax, the part of the body surrounded by the ribs.

Thy'roid gland, a gland in the front of the neck. It has an important effect on oxidation in the body.

Tissue, a collection of cells having a special work to do.

Tonsilli'tis, an infectious soreness of the tonsils.

Tonsils, two masses of flesh growing in the sides of the throat.

Tra'chea, the air tube leading from the throat to the lungs.

Tracho'ma, an infectious disease of the eyelids.

Tri'ceps, the muscle that bends the elbow.

Tuberculo'sis, a disease in which white bodies, like pinheads, form in the flesh; consumption.

Ul'na, the bone on the little finger side of the forearm.

U'rea, a waste substance in the urine. It contains the waste nitrogen of the body.

U'rine, the liquid secreted by the kidneys.

Vaccina'tion, protecting the body against smallpox by causing the germs of cowpox to grow in the body; also protecting the body against other diseases by injecting dead germs of the disease into the body.

Ventila'tion, keeping up a flow of fresh air into a room.

Ven'tricles, the two cavities in the lower end of the heart; they form the greater part of the heart.

Vermin, insects and small animals that are troublesome to man.

Vil'li, the small projections of mucous membrane that take up food from the intestine.

Vi'tamins, food substances that are needed in order that the body may make use of its building and fuel foods. They are abundant in milk and green vegetables.

Vocal cords, two bands of flesh by means of which the sounds of the voice are formed.

Wiggler, a young mosquito while it lives in the water.

Yeast, microscopic plants that change sugar to alcohol and carbon dioxide.

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